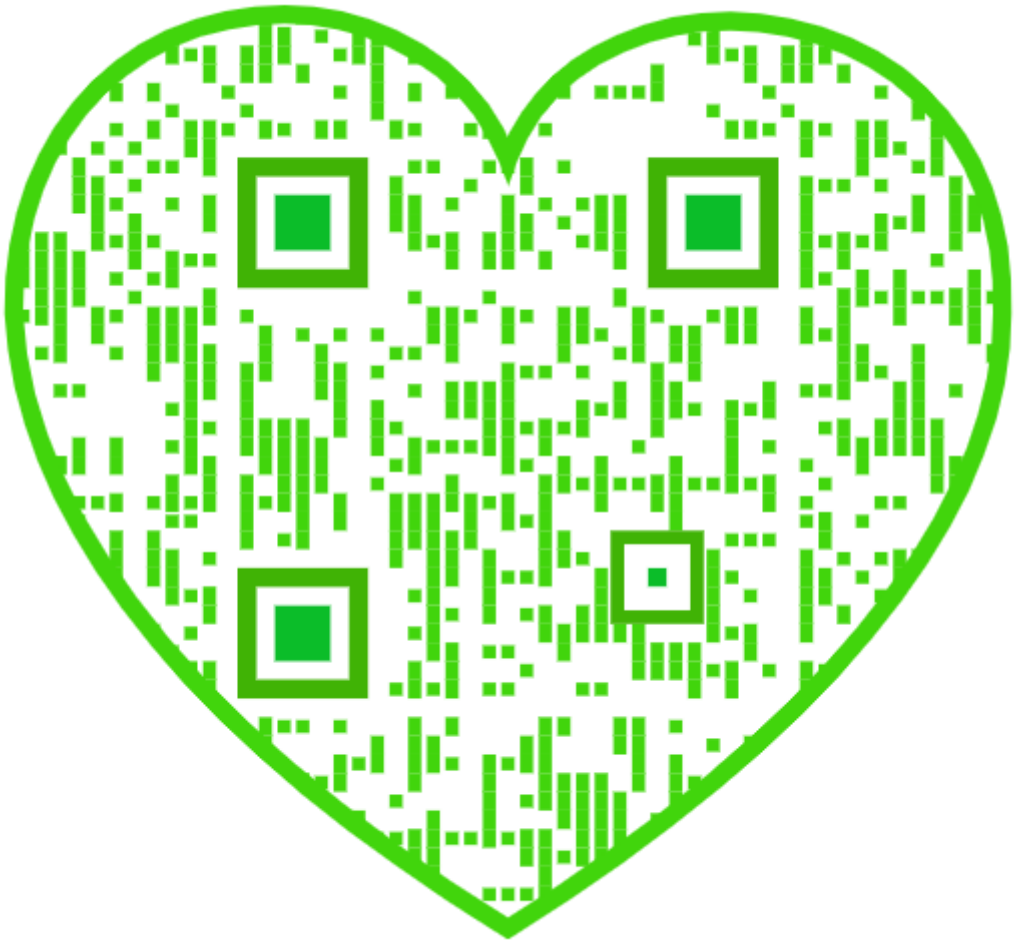
LEATHER MANUFACTURE

ALEXANDER WATT



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LEATHER MANUFACTURE

A PRACTICAL HANDBOOK

OF

TANNING, CURRYING, AND CHROME LEATHER DRESSING

By ALEXANDER WATT

AUTHOR OF "THE ART OF SOAP-MAKING," "ELECTRO-METALLURGY," ETC., ETC.

FIFTH EDITION, THOROUGHLY REVISED AND ENLARGED

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GENERAL

PREFACE.

The Author deems it advisable, in explanation of the appearance of the present volume, to mention that, notwithstanding diligent inquiry, he was unsuccessful in meeting with an English work on the subjects comprised therein. It is true there are articles upon Leather Manufacture in our various scientific cyclopædias and technical journals, but to the Author's mind it appeared strange that so important an art should be unrepresented by a special work upon the subject in this country, while other countries, especially France, Germany, and Austria, have provided numerous books upon the various branches of the trade.

It therefore seemed to the Author that a carefully prepared Handbook, embodying all the information he could gather which seemed likely to be useful to the various trades concerned, and including recent processes and improvements, could not fail to prove widely acceptable to manufacturers and others interested in the art. He consequently set to work to construct such a book, with the result which is now in the reader's hands.

In referring to the numerous sources of information

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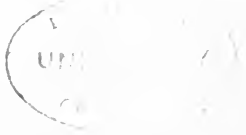
upon the subject, the Author was much surprised at the vast store of useful knowledge which was widely diffused through a considerable number of works and periodicals not directly addressed to the trade, much of which would probably never come within view of those for whom it was written. To these, and the several trade journals—*The Leather Trades' Circular*, *The Tanners' and Curriers' Journal*, and *The Scottish Leather Trader*—he gratefully acknowledges his indebtedness; as also to the several works referred to throughout the volume.

Soon after having determined to undertake the present work, the Author put himself in communication with several manufacturers, requesting permission to have a general view of their works, and to those who kindly acceded to his request he now returns his warmest thanks, but more especially to Messrs. Bevingtons & Sons, the eminent tanners of Bermondsey, and to Messrs. Carlaw Brothers, for the generous spirit in which they explained to him the various processes of manufacture conducted at their establishments. He has also to thank Mr. Sparke Evans, of the Avonside Tannery, Bristol, for many useful suggestions.

In conclusion, the Author indulges a hope that his effort to supply an evident want in English technical literature, may meet with the approval of his readers, and that the book will prove useful for reference to everyone connected with the art.



PUBLISHERS' NOTE TO THE FIFTH EDITION.

SINCE the issue (in 1897) of the Fourth edition of this work, as revised by the late Mr. Alexander Watt, rapid strides have been made in the Leather industry. In fact, so great and constant, it appears, are the advances now being made, that it is all but impossible to keep abreast of them in a technical Handbook. The Publishers felt assured, however, that much of the data here collated and prepared by Mr. Watt was far too valuable to be cast aside, and having, after that gentleman's death, received inquiries from all parts of the world as to when a revised edition would be available, they felt themselves fortunate to be able to engage the services of a well-known expert who was prepared (within the limits arranged) to thoroughly revise the work, and make such additions as should bring it up to date. This was by no means an easy task, but it is believed that the Reviser (while retaining such parts of Mr. Watt's work as were of permanent value) has succeeded in giving, also in a condensed and easily digestible form, a summary of most of the modern methods now pursued by Tanners and Leather Manufacturers. Several of the

original chapters, dealing with older-fashioned leathers which have practically passed out of use, have been omitted, their place being taken by descriptions of tanning and dressing the more modern leathers, such as chrome, calf, and goat skins. In some cases, the space available would not allow him to do more than give the bare technical outlines of the processes involved; and in others the Reviser has had to assume a certain amount of knowledge on the part of the reader.

A brief description has been added of the "Standard" method of tannin estimation, but the scientific reader who requires fuller information on this important subject is referred to Prof. H. R. Procter's "Leather Industries Laboratory Book," where he will find full justice done to the Chemistry of Leather Manufacture. The illustrations of machinery (it will be found) have been brought up to date, but it will not be forgotten that so rapid is the progress made by the Tanner's Engineer that new ideas for appliances are of almost daily occurrence. The introduction of the Chrome process of leather manufacture was a golden opportunity for mechanical enterprise, of which British, American, and Continental engineers have not been slow to avail themselves, and they are reaping a rich harvest in catering for the wants of the Tanner.

It is right to mention that the technical methods described in the work are such as have stood the test of practical experience, and although some of them may have to be modified to suit individual special or local requirements, yet it is certain that students of the subject will obtain much that is of real value from an intelligent perusal of what is here written. The recipes

given are not only actual working formulæ, but many of them have been hitherto regarded as trade secrets.

In conclusion, the Publishers may be allowed to quote the words of the Reviser, who has reminded them that "in the Manufacture of Leather competition is becoming keener year by year, and the cost of manual labour is making it almost prohibitive for many purposes. 'The old order changeth, giving place to the new,' but it is not without a pang of regret that even the most enterprising man sees the old forms of ancient skilled trades swept aside by the march of progress. However, this seems to be one of the inevitable trading conditions of the twentieth century. The day is over when profit could be made easily and quickly in the leather trade, and it is only by close study of economy in the manufacture, and careful organisation for the disposal of the product, that progress can be made. In pursuing the former of these two courses, close study, both of the science and of the practice of the Leather industry, is essential; and if what he has written and compiled in preparing the present edition is a help in that direction, the Reviser will feel that in his attempt to bring the work of the late Mr. Watt into line with modern methods he will have accomplished a most useful service for the followers of a most interesting calling."

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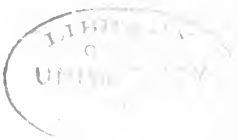

THE ART

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LEATHER MANUFACTURE

ERRATA IN TEXT.

Page vi., line 5, *for* 'chrome, calf' *read* 'chrome calf.'
,, xi., ,, 6, *for* 'Mr. Procter' *read* 'Prof. Procter.'
,, xi., ,, 8, *for* 'Standard Methods—International Association' *read* 'Standard Method of the International Association.'
,, xi., ,, 29 (Chapter Heading), *for* 'Raising or Swelling' *read* 'Deliming or Bating.'
,, xv., ,, 21, *for* 'Black' *read* 'Blacking.'
,, xv., ,, 29, *for* 'Leather Dressing Machinery' *read* 'Shaving and Splitting Machinery.'
,, 88, ,, 6, *for* 'Mr. Procter' *read* 'Prof. Procter.'
,, 88, ,, 8, *for* 'Standard Method.—International Association' *read* 'Standard Method of the International Association.'
138–142 (Chapter Heading), *for* 'Raising or Swelling' *read* 'Deliming or Bating.'
Page 399, line 6, *for* 'Leather Dressing Machinery' *read* 'Shaving and Splitting Machinery.'

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INTRODUCTION.

In future ages the past century will ever be famous, not only for its important discoveries and useful inventions, but it will also be marked as an era in which, however tardily at first, the teachings of Science were accepted, and many useful arts rescued from empiricism and ignorance. Even within the memory of many now living, the innovations of Science were formerly looked upon with suspicion, as being not only unnecessary but possibly fraught with mischief. What could chemists know about soap-making, or of the art of tanning hides? If good soap and good leather could be produced for so many generations without the aid of Science, why not continue in the same track as of old? Reflections such as these inspired the workers in these arts for a long time after they were proved to be based upon definite chemical laws; and it is well known that a deaf ear was turned to those who ventured to assert, and even to prove, that chemistry was indissolubly allied to those arts which had, from time immemorial, been conducted chiefly by the judgment of uneducated workmen.

Although it must be confessed that the discovery of the chemical principles involved in the art of tanning has not, in its application, improved the quality of leather, still this important knowledge has enabled the tanner to work with greater economy and certainty, while Chemical Science has furnished him with an abundance of tanning materials of which, without such aid, he would doubtless have remained in ignorance. Moreover, various

methods of quickening the process of tanning have been introduced which, in their turn, have facilitated the production of leather to meet the ever-increasing demand for this valuable article of universal requirement.

Respecting the early history of tanning, some very interesting facts are given in the *Gerber Courier* of Vienna, from which we extract the following:—"The oldest method of tanning is red or bark tanning, or that in which, in addition to the wooden and iron scraping and rubbing instrument used in the preparation or improvement of the hide or skin, limewater and astringent extracts from oak and other kinds of bark, or from other vegetable substances, are employed. It is called red tanning because the tanning substances always contain more or less colouring matter, which dye the leather through and through of a more or less reddish colour. The ancient Orientals understood the art of preparing not only common leather, but even good and often finely coloured varieties, similar to our Morocco and Cordovan. Persian and Babylonian leather has been celebrated time out of mind. Many centuries back such leather was brought from Asia into Europe—first into Turkey, Prussia, and Hungary, and thence, later, into Germany, Holland, England, France, Spain, &c., and these countries subsequently learned to manufacture leather themselves. In the first centuries of Christianity, the Turks, Russians, and Hungarians were the most celebrated tanners; subsequently England, the Netherlands, and Spain endeavoured to equal them.

"Among five sorts of leather of foreign origin, Cordovan, Morocco, Shagrin, and Russian leather have at all times been specially famous. Cordovan, a soft, small-grained, coloured leather, had already been prepared by the ancient Orientals. Its name is derived from the Spanish city of Cordova, whence it was possibly first introduced into Europe, and where, for a long time afterwards, it was chiefly manufactured. It enjoyed a great reputation in the eleventh century, when the most distinguished persons wore shoes of Cordovan leather. The

French name for shoemaker, 'cordonnier,' appears also to have been derived from this leather. From the gradual improvement of Cordovan, sprang Morocco, called also Turkish and Spanish leather. This beautifully coloured and brilliant leather has always been most excellently manufactured in Morocco, in European and Asiatic Turkey, in Krim Tartary, in the Island of Cyprus, &c., and very well also in Russia, Poland, Hungary, and Spain, but especially in England, France, Holland, and Germany.

"Shagrin (in Turkish *Sagri*, and Persian *Sagre*) is chiefly celebrated for its hardness and strength, and for the peculiarity of its grain side, which appears as if covered with globular granules. It is also of Eastern origin. The best Shagrin is now made in Persia, Constantinople, Algiers, and Tripoli. The production of the small globular granules on the grain side was for a long time kept secret. We were first informed by the celebrated traveller, Pallas, that they were produced by stamping the hard seeds of the *wild orach* (*Chenopodium allium*) into the hide spread on the ground. The seeds were afterwards knocked out, and the hide scraped on the indented side and soaked in water for two days. The Hungarians were, in ancient times, especially celebrated for their white tanned leather, which was imitated in France as long ago as three hundred years.

"We beg our readers to go back some centuries in history, and they will be convinced that the products of our trade were known in the time of Moses; for at that period leather carpets were already used in tents. These we may still meet with among the Arabs. Coloured leather seems also to have been common, for Ezekiel speaks of fine red leather, which was probably our splendid red Morocco. Leather was also used in the remotest ages by the Israelites as a material to write upon, for they used strips made of leather for this purpose. According to the testimony of Herodotus, the ancient Ismians wrote their annals upon sheepskin, and the ancient Persians likewise, according to Diodorus of Sicily. According to Herodotus, the ancient Libyans

wore leather clothing; the Ichthyophagists on the banks of the Araxes dressed themselves in sealskins; and in the time of Alexander the wild inhabitants of Geodrosia used the hides of animals for clothing, and covered their dwellings with leather. Homer praises the splendid half-boots of Agamemnon, and Hesiod recommends leather shoes lined with fur. For many years leather was used by the Greeks in the construction of ships, especially by the Phœnicians, who originally inhabited an arid, sandy corner of the earth between the Red Sea and the Mediterranean, where the soil was not favourable to the growth of timber, and they were obliged to supply its place by covering their boats, constructed of willows woven together, with leather or hides, which, even thus early, were subjected to a certain amount of dressing. The ancient Germans also, who lived on the sea-coast, and the original Britons, equally possessed this custom.

"It is asserted that the art of dressing leather in general, upon the so-called Hungarian method, was first brought from Senegal, in Africa, and made known to us in the middle of the sixteenth century by Buscher, the son of a tanner in Paris. At that time leather was common in Hungary, and dressed leather was very highly esteemed. In the year 1584 two German tanners, named Lasmagne and Aurand, came to Neufchatel, in Lorraine, where they worked at their trade; from thence they went to St. Deziers, in Champagne, and finally to Paris, where they prepared very good leather. The theory that the preparation or tanning of the hides was discovered centuries ago, and that the leather produced was employed for the same purposes as at present, is further confirmed by the following old proverb, which is proof that leather shoes were already worn at that time: 'We must not steal leather to give away shoes in God's name.' This refers to the legend of St. Crispin, who stole leather to make shoes out of it for the poor. In the old form of speech, 'to draw from the leather' signified to draw the sword. In low Saxon the same expression signifies to undress."

Although the preceding observations indicate that the writer believed that the art of converting skins and hides into leather was not only exceedingly ancient, but also widely diffused, it is equally probable—except among the early Egyptians,* who must have known a comparatively high state of civilisation—that the so-called leather was in reality the skin or hide of the slaughtered animal merely dried in the sun or smoke-cured, and not what we understand by the term leather. Indeed it is well known that untanned skins have from all time been used by uncivilised tribes (as is also the case at the present time) for clothing and many other purposes. In some parts of France, even at the present day, bottles are made from skins of animals sewn up, and are used for the conveyance of wine and oil. The skins of animals were also used for making vessels to contain liquids—even wine; but it is more than probable that the skins were merely dried in the sun and then externally greased to render them pliant and preserve them from the effects of moisture, or were *cured by smoking*, and not *tanned* in the ordinary sense. In support of this view, David, in Psalm cxix. 83, says, "I am become like a bottle in the smoke," which would indicate that the (skin) bottles in his time were cured by *smoking*. The preservative effects of the volatile matters given off by burnt wood were doubtless known at the earliest periods, and it is therefore reasonable to infer that the Psalmist alluded to this mode of preserving bottles made from the skins of smaller animals. Again, in the preceding verse, David says, "Mine eyes fail for thy word;" may not this, taken in conjunction with his subsequent complaint, indicate that his vision, being impaired, caused him to behold objects as through a mist—"like a bottle in the smoke." Job, in chap. xxx. 30, says, "My skin is black upon me, and my bones are burnt with heat,"

* In the Egyptian collection of the British Museum may be seen a leather workman's apron, with a small purse-shaped pocket at the right side; leather shoes with round toes, ankle and fore straps, most of them for children; also other shoes of coarser and stouter make, and sandals of various forms and sizes; shoes with high peaked toes; rolls of prepared leather of a maroon colour, a yoke with one leather strap remaining, &c.

probably also comparing his lamentable condition to that of a bottle being cured by the smoke from burnt wood. Our Saviour refers to the necessity of putting new wine into new bottles, "else the new wine doth burst the bottles." Assuming that such bottles were made from the skins of animals, it is obvious that in course of time, through long use, they would become *perished*, as it is termed, and in such a brittle condition as to render them incapable of withstanding the pressure of new wine.

In ancient writings the words skin and leather are evidently synonymous, but probably refer to the dried or *cured* skin. Kennett, in his *Antiquities of Rome*, speaking of the shoes, slippers, &c., worn by the ancient Romans, says, "The *perones* were a kind of high shoes, rudely formed of raw hides, and reaching up to the middle of the leg. . . . . Dacier tells us that the senators had two sorts of shoes, one for summer and the other for winter. The winter shoes were made of an entire black skin, or sometimes a white one, reaching up to cover the greater part of the leg, without any open place except at the top. . . . . It is uncertain whether the *calcei mullei* (red shoes) were so called from the colour of the mullet, or whether they lent a name to that fish from their reddish dye. They were at first the peculiar wear of the Alban kings, afterwards of the kings of Rome. . . . . Julius Cæsar, who was very singular in his whole habit, was particularly remarkable for wearing *mullei* on ordinary days. . . . . The Roman *soleæ* were a sort of sandals, without any upper leather, so that they covered only the sole of the foot, being fastened above with straps and buckles. These were the ordinary fashion of the women, and therefore counted scandalous in the other sex. . . . . The *crepida* had two soles, whereas the *soleæ* consisted but of one. The former word is supposed to be derived from *crepitus*, creaking, from the peculiar sound which the double soles produced. Momus, when brought to censure Venus, could find no fault in her except that her slippers creaked a little too much!" The Romans appear to have acquired a knowledge of leather manufacture at a

later period, and to have pursued it with great success. It is said that boots and shoes equal to those of the present age were worn by Roman ladies, and Pliny alludes to hides being tanned with bark, and also states that gall nuts, sumach, and lotus bark were employed in tanning.

About 1300 A.D., embossed leather of great beauty was produced, specimens of which, in the form of tapestry, are still preserved in some of our old English mansions. Spain, Italy, Flanders, and England were famous for the production of embossed leather richly coloured and gilt. This art having also been practised by the early Egyptians nearly three thousand years ago, it is probable that the countries above named may have revived and improved upon the Egyptian art.

It was not until the end of the eighteenth century, and the commencement of the nineteenth, that the subject of tanning received the attention of scientific men, and the great result of their investigations was that the *principles* of the process of tanning were fully developed, and the chemical action of the tanning agents upon the pelt, or unhaired skin, definitely determined. The researches of Lewis, Deyeux, Seguin, Macbride, Prevost, and Sir Humphry Davy established the fact that the process of tanning was a chemical art, and as such should be conducted with a due amount of scientific method. But many years elapsed—nearly half a century, indeed—before tanners would recognise any suggested improvement.

Up to about seventy years ago the tanners were men of small means, diffused throughout the country, unaided by railway communication and the advantages of machinery, while being utterly free from any knowledge of chemical principles. As a contrast to this condition of the trade, we have now an accumulation of extensive tanneries, many of which are situated near the great ports where the raw materials are landed from abroad; and the capital invested in these establishments runs into several millions. In some of these the principles of the art are not only understood but more or less generally followed, while the advantages of labour-saving

machinery have been recognised, and mechanical appliances adopted which the tanners of old would have looked at but to condemn.

As the principles of tanning became better understood, many attempts were made to hasten the tardy conversion of skins into leather, some of which, emanating from practical tanners, being not only ingenious, but possessing the merit of being of a fairly practical nature. The first of these processes was due to Francis Spilsbury, who, in 1823, took out a patent for a process by which the tanning liquor was forced through the skins by hydrostatic pressure. A modification of this process was introduced by William Drake in 1831, which consisted in having two skins sewn together, forming a watertight bag, in which the tanning liquor was introduced by means of a funnel; the bag being thus filled, was kept constantly in this condition until the tanning was complete. In 1826, Messrs. Knowlys and Duesbury procured a patent for hastening the impregnation of the skins with tanning liquor by suspending them in a close vessel, from which the air could be exhausted by means of an air-pump. By this method the skins were said to be so effectually impregnated with tannin that their conversion into leather was greatly accelerated.

Many other mechanical contrivances have from time to time been introduced, with a view to promote the rapid and uniform absorption of tannin by the skins, amongst which may be mentioned Nossiter's plan of separating the skins, while in the tan liquor, by wooden frames or partitions; Keasley's arrangement for raising and lowering the skins alternately during the tanning operation, as a substitute for "handling;" and, more recently, Bez and Sons' method of tanning hides by means of a continuous flow or current of tanning liquor. These and other processes will be described in the subsequent pages.

Since the period when Davy examined the chief tannin-yielding plants known in his time, a vast number of vegetables have contributed to the tanner's list of tanning materials, some of which, employed either alone or mixed

with other sources of tannin, have proved highly serviceable in the production of leather. Amongst these may be mentioned hemlock, valonia, mimosa, divi divi, myrobalans, quebracho, &c. The foremost of these—hemlock—is the chief tanning agent of the Northern States of America, in which it abounds in unlimited profusion. Oakwood and chestnut extract is also largely imported into this country from Canada and the Continent.

Many methods have been devised for the estimation of tannin, but the system proposed by Löwenthal, and somewhat modified by our own chemists, is now generally accepted as the most reliable. While the simpler methods of determining the percentage of tannin, by the amount of gelatine required for its precipitation, or by the amount of tannin which a given weight of dried skin absorbs, will afford an approximate estimate of the proportion of tannin in a sample of bark or other tannin material, Löwenthal's method is capable of giving far closer and more reliable results than any other at present known.*

Expatiating on the importance and extent of the leather manufacture in this country, Dr. Campbell says: "If we look abroad, on the instruments of husbandry, on the implements used in most mechanical trades, on the structure of a multitude of engines and machines; or if we contemplate at home the necessary parts of our clothing—shoes, boots, and gloves—or the furniture of our houses, the books on our shelves, the harness of our horses, and even the substance of our carriages, what do we see but instances of human industry exerted upon leather! What an aptitude has this single material, in a variety of circumstances, for the relief of our necessities and supplying conveniences in every state and stage of life! Without it, or even without it in the plenty we have it, to what difficulties should we be exposed!

* Since the above was written, the "Standard Method," as adopted by the International Association of Leather Trade Chemists, is now generally used by European chemists for tannin estimation. A condensed description of this is given at the end of chap. viii. p. 104.—Ed. *Fifth Edition.*

While, in the early part of the past century, the soapmaker was constantly under the surveillance of the exciseman, the tanner was equally favoured by the constant presence of that official supervisor; at the soapworks, the coppers were locked and unlocked night and morning by the exciseman, while at the tanyard not a single hide could be shifted without his supervision, and in the case of any breach of the excise laws heavy penalties were inflicted. In the year 1830 the leather tax was abolished, and as evidence of the great impetus which this caused to the trade, in the year 1828 the value of exports of leather and saddlery were, collectively, £183,361, while in 1882 these exports amounted to £2,348,242.

Since that date, British trade in leather and leather goods has shown continued expansion. In 1905, leather to the value of £2,112,823 was exported, boots and shoes £1,882,294, and saddlery and harness to the value of £518,082. This, it must be remembered too, has been done in the face of ever-increasing hostile tariffs, for even the Australian Commonwealth has so raised the import duties, that it now only pays to send the finest classes of leather goods to the Antipodes.

CHAPTER I.

CHEMICAL THEORY OF THE TANNING PROCESS.

Properties of Gelatine.—Action of Tannic Acid on Gelatine, &c.—Seguin's Theory of the Art of Tanning.

THE process of tanning consists in the conversion of the skins of animals into leather, by chemically combining with the substance of the skin an astringent vegetable principle called *tannin*, or *tannic acid;* and in order to thoroughly understand why this conversion takes place when skins are immersed in a solution of the tanning principle, we must know something of the chemical composition of the skin itself. When the *cuticle,* or scarf skin, has been removed from the *cutis,* or true skin, it is found that the latter is almost entirely soluble when boiled in water, and the solution, after evaporation and cooling, sets into a jelly—this is *gelatine,* a substance which readily combines with tannic acid. Gelatine is also obtained in the same way from bones, cartilages, tendons, and ligaments. The purest form of gelatine is *isinglass,* prepared from the air-bladders and sounds of the sturgeon.

Properties of Gelatine.—Pure gelatine is colourless, without odour, insipid to the taste, and transparent; it is more or less tough, according to the source from which it is obtained. It is heavier than water, and when heated, it first becomes soft, and then shrinks. When burned, it exhales an odour resembling that of burnt horn. In cold water gelatine softens and swells, but only partially dissolves; with gentle heat, however, it dissolves freely. Good glue, immersed in cold water, absorbs about three or four times its own weight of that liquid without dissolving.

One part of isinglass dissolved in 100 parts of water, gelatinises on cooling; but in 150 parts of water it remains liquid; the gelatinising of the solution, however, will naturally depend upon the temperature of the atmosphere and the quality of the gelatine. The skins and tissues of the older animals yield a firmer jelly than those from younger ones. According to Brande, when a solution of gelatine is repeatedly warmed and cooled, more especially if it be boiled, it gradually loses its tendency to gelatinise, and becomes more and more soluble. In close vessels jelly may be kept in cool weather for some days without change; but in open vessels it soon becomes mouldy, especially in the vicinity of flowering plants. "Gelatine is not soluble in absolute alcohol, and when alcohol is added to a warm and strong aqueous solution, the gelatine separates in the form of a white viscid substance. It is insoluble in ether, and in fixed and volatile oils. When common gelatine, glue for instance, is digested in alcohol, it yields a little fat and extractive matter to that solvent. When jelly is immersed in alcohol, it contracts very considerably in consequence of the abstraction of water; it was thus that Gonner applied it for the reduction in size of the impression of lithographic prints; and, on the other hand, when the original impression was taken upon contracted gelatine, it could be so dilated by immersion in water, as to give a greatly enlarged impression of a small print."—*Brande.**

Gelatine is soluble in all dilute acids, in which respect it differs from albumen. When treated with sulphuric acid, *leucine* and *gelatine sugar* are formed, the latter substance having been discovered by Braconnot. One part of pulverised glue was mixed with two parts of concentrated sulphuric acid; after having been left in this condition for twenty-four hours, during which time no discoloration took place, eight parts of water were added, and the mixture boiled for five hours, the water being renewed occasionally. The liquor was then further diluted, and saturated with chalk, then filtered and evaporated, when

* "Manual of Chemistry." By William Thomas Brande, F.R.S., &c.

it yielded a syrup which, at the end of a month, produced small sweet crystals. These were afterwards washed with weak alcohol to separate the adhering syrup, and purified by a second crystallisation. Gelatine sugar requires 414 parts of water to dissolve it.

Action of Tannic Acid on Gelatine, &c.—The most delicate test for the presence of gelatine is tannic acid, and when we consider that a cloudy precipitate is produced by this vegetable acid in a solution consisting of 1 part gelatine in 5,000 parts of water, we may begin to realise its powerful influence upon the skin of animals in the process of tanning. When a piece of prepared skin—that is skin which has been soaked in milk of lime and freed from its cuticle, hair and other extraneous matters—is immersed in a solution of pure tannin (tannic acid) or an infusion of any astringent vegetable containing tannin, such as oak bark or gall nuts, and allowed to remain therein for a moderate length of time, the whole of the tannin combines with the skin, which becomes hardened and insoluble in water, and is absolutely incapable of putrefaction. It is, in fact, *leather*, and is almost impenetrable to water.

The characteristic properties of tannin are astringency in taste, and the power of being precipitated from its aqueous solution by a persalt of iron, either of a bluish-black, or a dark green colour. The colour of the precipitate, formed in a solution of tannin by *persalts* of iron, has been made the basis of an arrangement of the different tannins into two varieties, distinguished as 1, tannin which precipitates iron *bluish-black*, and 2, tannin which precipitates iron *green*. Upon this subject Gmelin says:—

"On the validity of the distinction between iron *blueing* and iron *greening* tannin, several views have been put forward, in which, however, these denominations have been understood as applying to two groups of bodies. If, according to Geiger, water containing a small quantity of alkali be gradually added to a ferric salt [as *per*sulphate of iron], which has been turned green by any kind of iron

greening tannin, the green colour changes to violet-black, the tint usually produced by iron blueing tannin. On adding an acid, the green colour is restored. According to this result, the difference between the two groups might be that the iron blueing tannin is less rich in free acid; nevertheless, it reddens litmus more strongly than the other kinds of tannin. It appears to contain [*qy.* to be capable of yielding] a larger proportion of gallic acid, but iron blueing tannin is not converted into the iron greening kind by the addition of gallic acid (*Gmelin*). The blue or green reaction is by no means an infallible characteristic of the species of tannic acid, since bases colour the ferric compounds of tannic acid blue, and acids change the blue to green. With ferric acetate, the iron greening acids form a blue compound; the green compound which they form with other ferric salts is turned blue by the addition of a sufficient quantity of acetate of lead, either neutral or basic, and even by a large quantity of gelatine. A compound of iron greening tannic acid with lead oxide, is turned blue by ferric sulphate (persulphate of iron); an iron greening tannic acid is turned blue by exposure to the air, in contact with iron turnings. But the colours obtained with iron greening tannic acids are very different from those produced by the iron blueing acids, and the two cannot be converted one into the other.

"Thus, catechu-tannic acid (obtained by exhausting catechu with a small quantity of water), left in contact for a few days with iron filings, assumes a dirty-greyish, not a blue-black colour, and the precipitate does not turn green when treated with a small quantity of acetic acid, but dissolves on the addition of a larger quantity, and is precipitated a purple-grey on the addition of ammonia. The iron greening tannic acids of catechu, kino, alder, larch, and birch bark, and of tormentilla root, are likewise incapable of yielding a good ink. The extracts of iron greening parts of plants do not yield pyro-gallic acid by dry distillation, unless they contain gallic acid ready formed" (*Stenhouse*). This also shows the incorrectness of

the view advanced by Heming, who regards the two groups as not essentially different from gallo-tannin, and as identical therewith, when pure.

Dr. Lewis was the first to attempt a chemical analysis of nut-galls, about the middle of the last century, and he detected in them a substance "which coagulates with isinglass, and blackens the salts of iron." Seguin, however, is believed to have been the first to accurately determine the nature of this peculiar action upon gelatine, and also upon the skins of animals, and the term *tannin* was applied by him to this principle as existing in a variety of vegetable substances employed in the conversion of skins and hides into leather. Proust was the first who attempted to obtain tannin in a pure and separate state, and Sir H. Davy determined its relative quantity in a variety of tanning materials. It was not, however, until 1834 that Pelouze discovered a method of separating tannic acid in a pure state (see p. 43).

Although subsequent researches have to some extent disproved the theory which Seguin promulgated at a time when little was known of the principles of tanning, its reproduction here will not be out of place, more especially as it will enable us to give the views of other chemists of eminence concerning the weaker points of his theory.

Seguin's Theory of the Art of Tanning.—1. The skin, stripped of its flesh, is a substance which can be easily converted by a convenient process into an animal jelly, which, concentrated and dried in the air, furnishes glue.

2. A solution of this latter substance being mixed with an infusion of tan, an insoluble precipitate is formed, and this precipitate is not susceptible of putrefaction.

3. The solution of tan is composed of two distinct substances; one precipitates the glue, and is the true tanning matter; the other precipitates the protosulphate of iron, without precipitating the solution of glue, and produces only the disoxygenation of the skin, and of the substance which unites the hair to the skin.

4. The operation of tanning is not a simple combination

of the skin with the principle which precipitates the glue, but a combination with the skin disoxygenised by the substance which in dissolution in the tan has the property of precipitating the sulphate of iron. Thus all substances to be used to tan ought to have the properties of precipitating glue and sulphate of iron.

5. The operation of tanning consists, first, in the swelling of the skins by an acid principle; second, a disoxygenation by gallic acid; third, in disoxygenating the skin by the same principle; and by this disoxygenation it is in a middle state between glue and skin; fourth, in combining it by this disoxygenation.

That Seguin was in error in supposing that gallic acid entered into the substance of the skin in any considerable proportion, if at all, there cannot be the least doubt. Indeed it has been abundantly proved that such is not the case, and the examination of the exhausted or spent tan liquors detects the presence of this acid in considerable proportion. Dr. Ure says, "In no case is there any reason to believe that the gallic acid of astringent vegetables is absorbed in the process of making leather; hence Seguin's theory of the agency of that substance in disoxygenating skin, falls to the ground." Dussauce* gives the following reasons for disagreeing with Seguin's theory: "Whatever are the merits of Seguin, and the services he has rendered, we cannot but expose all the errors of the above theory. We persist in looking at the swelling of the skin as an effect less chemical than mechanical, which is principally due to the interposition of the water, or to the effect of the caloric produced by fermentation. Acids and alkalies act only as a means of preserving the skin from putrefaction; afterwards they effect a chemical action. Thus the lime with which the interior of the skin is saturated, notwithstanding all the washings, forms with tannin a tannate of lime, which takes away the suppleness of the leather, and for this reason it is that the lime method is injurious. It

* "Treatise on the Art of Tanning," &c. Edited from Notes and Documents of Sallerou, Grouvelle, Duval, Dessables, Labarraque, Payen, René, De Fontenelle, Malepyre, &c., &c. By Professor H. Dussauce.

is not the same with acids. Besides preserving the skin from putrefaction, the acetic acid produced reacts on the fibrine, softens it, and transforms it partly into a transparent jelly, soluble in boiling water, and combining with the tannin. Besides this the acid, by which the skin is more or less saturated, precipitates the solution of tannin, and fixes a larger quantity in the leather. This softening renders the swelling very easy. However, it can be operated without these means, which are in antagonism with Seguin's theory.

"We do not agree with Seguin that gallic acid is the principal and indispensable agent in tanning. No experiment has demonstrated the durable disoxygenation which he asserts, and which is impossible, if we compare the respective constituents of gelatin and fibrin. Thus:—

Fibrin contains	19·615	per cent.	of oxygen.
Gelatin ,,	72·207	,,	,,

"From this we see it is impossible that gallic acid disoxygenises the fibrine and transforms it into glue, whilst pure gelatin contains nearly one-half more of oxygen. If such were the case, gallic acid must oxidise instead of disoxygenising. We therefore see that this theory is inadmissible. Let us now record the experiment:—

Catechu contains from	48 to 54	per cent.	of tannin.
Tea ,,	34 to 40	,,	,,
Herb Bennet ,,	42	,,	,,
Squill ,,	24	,,	,,

"These substances, so rich in tannin, are applied with success in tanning; while, however, they do not contain a particle of gallic acid. Seguin does not mention the extractive; however, this substance has some action in the tanning, and according to Sir H. Davy its presence is necessary to form a flexible leather, and in some way it may take the place of tannin. In England, where tanning material is very scarce, they have used the decoction of cicuta, and Schwerger has shown by analysis that 100 parts of fresh leaves contain 2·73 of extractive, without

tannin or gallic acid. To resume, we regard tanning as, a combination of five principles: *fibrin, gelatin, tannin extractive,* and *acid.*

"1. Gelatine and fibrin are transformed into a jelly by acetic acid, with tannin, extractive, and gallic acid.

"2. In tanning, the epidermis disappears, and no portions of the skin have been disoxygenated.

"3. The action of gallic acid is similar to that of acetic acid, and its presence is not necessary in the operation.

"4. Extractive, like tannin, unites with the altered gelatin and fibrin, and renders leather flexible and firm. It is also their colouring principle; thus leather tanned with gall is pale, that with oak bark brownish, with catechu reddish, &c. It is the extractive which gives the leather a brownish colour, without rendering it insoluble in boiling water.

"5. Lime forms with tannin a tannate of lime, which destroys the suppleness of the leather, and renders it dry and brittle.

"6. Dried skins, well tanned, increase in weight about 33 per cent. This increase is due to the fixation of the tannin, extractive, gallic acid, (?) and a little water.

"7. In saturated infusions there is less extractive than tannin,* which in weak solutions predominates. That is the reason why it is necessary to place the skins at first in very weak infusions, and lastly to saturate them little by little, with tannic acid and extractive, so as to have a complete tanning and more supple leather.

"8. By presenting to strong infusions, the leather contains but very little extractive, and is tanned only on two surfaces, the centre containing little, so that the leather obtained is hard and brittle.

"9. Lastly, gallic acid exercises so slight influence on tanning that Sir H. Davy thinks that it is doubtful if oak bark contains any."

The above observations, taken collectively as the opinions of Dussauce, Malepyre, Payen, René, Labarraque, de Fontenelle and others, and supporting as they do the views of

* Davy.

that distinguished philosopher, Sir Humphry Davy, cannot fail to prove instructive to those who desire to pursue the art of tanning upon truly scientific principles. While disagreeing with Seguin's views as to the part which gallic acid plays in the process of tanning, we must not forget the great services he rendered to the followers of the tanning art by explaining the main principles upon which the art is based, and which, prior to his researches, were but little understood.

As we have before shown, the process of tanning essentially consists in forming a chemical combination of the *corium*, or true skin of animals, with the vegetable astringent principle *tannin*. If skins were merely dried—although they would possess a certain degree of hardness and durability while in that state, they would, when subjected to moisture, undergo putrefaction, and consequent speedy destruction. Again, untanned skins are pervious to water, and therefore cannot be used for the many purposes to which leather is so extensively applied. When skins are tanned, however, not only is their chemical constitution changed, but they are also rendered impermeable to water, besides being absolutely unputrefiable. Moreover, during the combination of tannin with the skin it is believed that vegetable extractive matter from the bark, &c., also enters somewhat largely into the substance of the skin, to which, no doubt, some of the valuable properties of leather are due. Sir H. Davy observes upon this subject:—

"When skin is very slowly tanned in weak solutions of the barks, or of catechu, it combines with a considerable proportion of extractive matter; and in these cases, though the increase of the weight of the skin is comparatively small, yet it is rendered perfectly insoluble in water, forming a soft, but at the same time a strong, leather. The saturated astringent infusions of barks contain much less extractive matter in proportion to their tannin than the weak infusions; and when the skin is quickly tanned in them common experience shows that it produces leather less durable than the leather slowly formed. Besides,

in the case of quick tanning, by means of infusions of barks, a quantity of vegetable extractive matter is lost to the manufacturer which might have been made to enter into the composition of the leather." These observations show that there is sufficient foundation for the opinion of the workmen concerning what is technically called the *feeding* of leather, in the slow method of tanning; and though the processes of the art may in some cases be protracted for an unnecessary length of time, yet in general they appear to have arrived, in consequence of repeated practical experiment, at a degree of perfection (in the *quality* of the leather) which cannot be very far exceeded by any elucidations of theory that have yet been made known.

It must be confessed that the old tanners, although they may be said to have worked upon the rule-of-thumb principle, often had for their guidance those useful substitutes for scientific knowledge—good common sense and keen observation. Hence we find that they discovered, in practice, that hides tanned slowly produced the best leather, in which view they were supported by Sir Humphry Davy, who found that saturated infusions of astringent barks contained much less extractive matter in proportion to their tannin than weak infusions. Davy further observes, "On the first view it appears singular that in those cases where extractive matter forms a certain portion of the leather, the increase of weight is less than when the skin is combined with pure tannin; but the fact is easily accounted for when we consider that the attraction of skin for tannin must be probably weakened by its union with extractive matter; and whether we suppose that the tannin and extractive matter enter together in combination with the matter of the skin, or unite with separate portions of it, still, in either case, the primary attraction of tannin for the skin must be to a certain extent diminished."

"In examining astringent vegetables," says Davy, "in relation to their powers of tanning skin, it is necessary to take into account not only the quantity they contain of the *substance* precipitable by gelatine, but like-

wise the quantity and nature of the extractive matter; and in some cases of comparison it is essential to employ infusions of the same degree of concentration. It is evident that of all the astringent substances which have been as yet examined, catechu is that which contains the largest proportion of tannin; and supposing, according to common estimation, that from 4 to 5 lbs. of common oak bark are required to produce 1 lb. of leather, it appears from the various synthetical experiments that about half a pound of catechu would answer the same purpose."

Mr. Purkis found that 1 lb. of Bombay catechu was equivalent to 7 or 8 lbs. of oak bark; and that, allowing for the difference in the composition of the different kinds of leather, 1 lb. of catechu, for the common uses of the tanner, would be nearly equal to 2½ lbs. of galls, to 7 lbs. of Leicester willow, to 11 lbs. of Spanish chestnut bark, to 18 lbs. of elm bark, to 21 lbs. of common willow bark, and to 3 lbs. of sumac.

Dr. Ure remarks,* "The older tanners, who prided themselves on producing a substantial article, were so much impressed with the advantages of slowly impregnating skin with astringent matter that they employed no concentrated infusion (*ooze*) in their pits, but stratified the skins with abundance of ground bark, and covered them with soft water, knowing that its active principles are very soluble, and that, by being gradually extracted, they would penetrate uniformly the whole of the animal fibres, instead of acting chiefly upon the surface and making brittle leather, as the strong infusions never fail to do. In fact, 100 lbs. of skin, quickly tanned in a strong infusion of bark, produce 137 lbs. of leather; while 100 lbs., slowly tanned in a weak infusion, produce only 117½ lbs. The additional 19½ lbs. weight in the former case serve merely to swell the tanner's bill, while they deteriorate the leather and cause it to contain much less of the textile animal solid. Leather thus highly charged with tannin is, moreover, so spongy as to allow moisture to pass through its pores, to the great discomfort and danger of persons who

* "Dictionary of Arts, Manufactures," &c. By Andrew Ure, M.D.

wear shoes made of it. That the saving of time and the increase of product are temptations strong enough to induce many modern tanners to steep their skins in a succession of strong infusions of bark is sufficiently intelligible, but that any shoemaker should be so ignorant or so foolish as to proclaim that his leather is made by a process so injurious to its quality is unaccountably stupid."

During the process of tanning, more especially by the modern system, in which infusions of bark and other tanning materials are used, chemical decomposition of a portion of the tannin takes place by a process of fermentation, by which gallic acid—a useless product to the tanner—is formed. This will be considered in the chapter on *Gallic Fermentation*, and the various remedies for its prevention duly given.

CHAPTER II.

THE SKIN.

The Skin.—Structure of the Skin.—Mr. Ashe's Description of the Skin.—Composition of the Skin.

The Skin.—It is of the first importance to the tanner that he should be acquainted with the anatomical structure of that part of the animal—the skin—the treatment of which constitutes his art. This knowledge is more especially necessary, since not only does the cuticle, or outer surface of the skin, resist the action of the tanning principle, but the underlying substance, the *true skin*, when brought in contact with tan, or tannin, undergoes a definite chemical change, by which its whole character and properties are completely altered.

Structure of the Skin.—The skin of animals consists of two distinct layers, which are thus classified: 1. The *Cuticle, epidermis,* or *scarf skin;* and 2. The *Cutis, corium,* or *true skin* (*cutis vera*). The cuticle varies in thickness in different animals, and in different parts of the body; it is insoluble in water, alcohol, and dilute acids; strong acids soften it, and ultimately dissolve it, while solutions of caustic alkalies, as soda and potassa, freely dissolve it, even when very dilute. The cuticle readily absorbs certain colouring matters, which impart to it a permanent dye. Between the cuticle and the corium is the *areolar tissue,* formerly termed the *rete mucosum,* in which the roots of the hair are embedded. This tissue contains the colouring matter which gives to the skin its characteristic tint, and which is much influenced by the action of light. "The black skin of the African," says Brande, "the brown of the Asiatic and American, and the pinkish-white

of the European, derive their colour from this peculiar secretion deposited between the *cutis* and *cuticle;* the nature of this substance has not been chemically investigated, but it has been ascertained, in regard to the *black* of the negro, that it admits of being bleached by chlorine."

The *cutis,* or true skin, is of a fibrous texture, almost wholly soluble when boiled in water, and the solution, when cold, forms a tremulous jelly, which is *gelatine*—the chief constituent of the cutis, or that part of the skin which, when submitted to the action of tannic acid, constitutes *tanned leather,* or more properly, *tanned skin.*

The structure and functions of the human skin are admirably described by Mr. Ashe in a valuable paper upon this subject; although objection may be taken to our having chosen this author's description of the human skin instead of giving that of the ox or other inferior animal, we venture to suggest that for the purposes of the tanner, who practically requires merely to know the structure of the skin and its functions *generally,* without troubling himself about the comparative anatomy of the subject—the full and minute description given by Mr. Ashe will enable him to comprehend the true character of the delicate fibrous structure of the *cutis,* which, when separated from its *cuticle,* hair, and fleshy matters, constitutes the *pelt* or part of the hide to be tanned. Moreover, when the fibrous texture of the unhaired skin is thoroughly understood, the tanner is better able to regulate and control its proper treatment in the various stages of the several processes which constitute the art of tanning.

Mr. Ashe's Description of the Skin.—"The *cutis,* or true skin, rests upon a very fine interlaced or netted structure, called the *areolar tissue,* out of which, if we may so express it, the granules and fibres of the skin are formed. The cuticle, or scarf skin, is never of any great thickness in any animal, but the true skin is of very variable thickness. In the whale the cutis attains the thickness of about an inch, which is the greatest known in any animal. The *cuticle* consists of several layers of laminated scales, the laminated form being best marked at the very surface,

where the scales are constantly falling off, as a kind of scarf, and are as constantly being renewed from below. These scales are formed by the flattening out of granules, more or less rounded, which is the form assumed by the particles of the cuticle in its deeper layers. These granules are at first nucleated* cells, and the colouring matter of the skin resides in the nuclei; and it was these granules that were formerly described as a separate layer, under the name of *rete mucosum*. They are very minute, being about $\frac{1}{3000}$ part of an inch in diameter at first. Being removed from below, as the flattened scales are removed from above, they gradually approach the surface, and as they do so they more and more lose the granular form, and assume the scaly character, their diameter increasing accordingly to about $\frac{1}{600}$ of an inch. Into the epidermis, or cuticle, no nerves or blood vessels penetrate, and it is nourished merely by the transudation† of the serum of the blood through the walls of the vessels of the true skin and subcutaneous areolar tissue. It is not itself sensitive, but on the contrary, serves to blunt the too exquisite sensation of the true skin, which is much more highly organised, and consists of two kinds of tissue, namely, white and yellow fibres, the former being denser and more resisting, and being therefore present in greater quantity wherever resistance is most needed, as in the palm of the hand and sole of the foot; while the yellow fibres are a highly elastic tissue, owing to their minute fibrillæ being arranged in interlacing curves; and the fibres cross each other repeatedly, and branch, so as to form lozenge-shaped interstices, which are filled up principally by the white fibres. The yellow fibres accordingly, as might have been anticipated, exist in greater abundance where elasticity is a special requirement, as at the flexures of the joints, the lips, &c. The uppermost surface of the cutis, or true skin, is strangely uneven and irregular, being elevated into a vast number of minute papillæ, which are about $\frac{1}{100}$ of an inch in height and $\frac{1}{250}$ of an inch in diameter. Minute as these little

* From *nucleus*, a body round which anything is collected or deposited.
† Passing through as vapour.

papillæ are, each possesses a ramification of vascular capillaries, and of nerve fibres, being, in fact, the essential agents in the sense of touch, for that is the function of these papillæ. The skin of the tongue in men and animals shows the papillæ larger than in any other part of the body." The accompanying illustration (Fig. 1) represents a highly magnified view of the skin, with its secreting glands and perspiratory ducts. *a* is the *cuticle*, or scarf skin; *b* the *areolar tissue*, and *c* the *cutis*, or true skin.

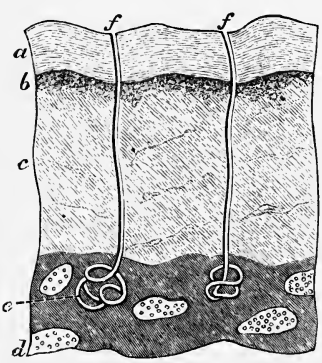

Fig. 1.

"The true skin is perforated by perspiratory ducts (*f*), and when the hand is warm the perspiration may be observed, even with the naked eye, to issue from them, forming minute shining dots. The glands (*e*) by which the perspiration is secreted, are seated at the under surface of the true skin, each embedded in a cavity of it. These glands are consequently to be regarded as true excretory organs, removing from the blood materials that are no longer wanted, and which, if retained, would be injurious. About 2,500 of these ducts are found in the square inch of the skin.

"Another kind of gland is also formed in the skin, in connection with the hairs, and engaged in their nutrition; these glands are called *sebaceous glands* (*d*); the ducts of these glands are not spiral, and they open generally into the hair follicles or pits which the hair grows out of, situated in the subcutaneous areolar tissue; these glands lubricate the skin, and so maintain its elasticity: and they also eliminate hydrocarbons from the skin."

It will be seen from the above observations that the *direction* of the secreted fluids of the true skin is *outward*,

or in the direction of the cuticle, consequently the absorption of tanning material would be more powerful at the *flesh* side than at the *grain* side of the skin.

Composition of the Skin.—A piece of fresh skin, freed on its internal side from fat and cellular tissue, and on its external side from the epidermis (cuticle) and the mucous membrane (areolar tissue), which lies between the epidermis and the true skin, contains about 43 per cent. of solid matter, the remainder being water. Of the solid matter about 32 per cent. of the weight of the humid skin is the fibrous and cellular tissue, and a little fatty matter, each of which is insoluble in cold water; 1·5 per cent. is uncoagulated albumen. About 1 per cent. is a variety of extractive matter, soluble in water and alcohol, and 7·5 per cent. is another kind of extractive matter, soluble in water, but insoluble in alcohol.—*Weinholt.*

Nearly the whole of the albumen and other matters capable of being dissolved by cold water may be separated by digesting the skin in that liquid. When the washed skin is dried and digested in ether, a small quantity of fatty matter is dissolved out. By digestion in boiling water the greater part of the true skin becomes altered in properties and dissolved; only some vascular and nervous filaments, with a little fat, remaining undissolved, and the solution, when slowly evaporated, leaves a residue of gelatine, or glue.—*Parnell.* According to Berzelius, gelatine does not exist, as such, in the living body, but several animal tissues, such as skin, cartilages, tendons, the serous membranes and bones, are susceptible of being converted into it by the action of boiling water. The term *gelatinous tissue* is commonly used to designate all animal tissues which are convertible into gelatine by such a process. Dilute acids and alkalies possess the property of converting gelatinous tissues into gelatine even at the ordinary temperature.

CHAPTER III.

HIDES AND SKINS.

Classification of the Skins of Animals.—Condition of Hides and Skins.—Hides.—Native Hides.—Dried Hides.—Salted Hides.—Dried Salted Hides.—Selection of Hides.—Warbles.—Abusive Treatment of Raw Hides.—Kips.—Buffalo Hides.—Horse Hides.—Ass and Mule Hides.—Hippopotamus Hides.—Calves' Skins.—Sheep Skins.—Lamb Skins.—Goat Skins.—Kid Skins.—Hog and Pig Skins.—Seal Skins.—Deer Skins.—Porpoise Skins.—Serpent and Crocodile Skins.

Classification of the Skins of Animals.—These are known, commercially, under three different heads, namely—1. *Hides*, or the skins of the larger and full-grown animals, as the ox, cow, bull, buffalo, horse, and hippopotamus; 2. *Kips*, or the skins of the smaller Indian animals of the bovine class; and 3. *Skins*, as those of the smaller animals, such as the calf, sheep, goat, deer, &c. The skins which are most extensively used in the manufacture of the various kinds of leather are those of the ox, cow, bull, horse, calf, sheep, goat, kid, pig, deer, seal, and *kips;* but the skins of crocodiles, alligators, and even serpents are also employed for making certain kinds of fancy leathers.

Condition of Hides and Skins.—The quality of hides and skins is greatly influenced by the conditions under which the animal has grown, the nature of its food, the variety of breed, climate, the state of its constitution, its age, and the time of year at which it has been slaughtered. The hides of the larger oxen form, when tanned, a stouter and heavier leather than those of cows, especially if the latter are from old animals or from those which have calved several times. The hides of bulls are of coarser grain and thinner in the back, or *butt*, than those of oxen and heifers, or young cows, although they are stouter in

the neck and certain parts of the belly. Muspratt says, "Hides of animals dying in a state of disease are found to be much inferior to those of healthy ones of the same class, although the apparent difference is not very marked before tanning. No very definite *criteria* are known to guide the purchaser in distinguishing the quality of hides and skins. If the hide be thin, flabby, soft, and will not bear handling, then such a one will not make good leather; but should it present the opposite qualities, it may be confidently expected to be a good article. It has been remarked of sheep that the skin gains in thickness and quality considerably in the course of a few days after shearing."

Hides.—Under this heading are included the skins of oxen, cows, horses, and buffaloes. The hides are distinguished as—1. *Fresh*, or *green hides*, or those which come from the slaughter-houses of Great Britain; 2. *Dried hides*, as imported from Buenos Ayres, the Cape of Good Hope, &c.; 3. *Salted hides*, those which come from Rio Grande, River Plate, Australia, &c.; and 4. *Dried and salted hides*, as imported from Brazil, Mauritius, West Indies, and other countries. Although the hides of home production are held in the highest estimation, the imported dried and salted hides, when subjected to certain preparatory processes to bring them into the condition of *green* hides, form, when tanned, most excellent leather. The trouble and labour involved in softening the dried skins naturally favours a more ready market for those of home production; nevertheless we import enormous quantities of hides and skins from all parts of the world, but more especially from South America. The vast pampas through which the River Plate (or Silver River) and its tributaries flow, yield boundless pastures for wild or partially wild oxen and horses, which have been estimated to number nearly 25,000,000. Indeed, the climate of this district seems specially suited to the rearing of cattle, which are descended from the tame animals first introduced by the Spaniards after Columbus' discovery. The Buenos Ayres hides obtained from the most southern states are considered stouter and of finer texture than those of Uruguay or Rio Grande. The hides from the more tem-

perate regions are salted, and exported as *wet salted*, while those from the tropics are generally dried in the sun, or *salted and dried*. Dry salted hides are largely exported from Brazil, Mauritius, Madagascar, &c.

Native Hides, or those of home slaughter, differ greatly in substance, size, and texture; while those from the south of England yield large and heavy hides of fine texture and grain, they are much thinner than the smaller hides of the north of Scotland. The fattening of cattle for the production of good beef, to suit the English market, renders the hides, although of great size and weight, considerably thinner than those from cattle subjected to less culture. The hides of heifers are preferred to those of cows which have calved several times, owing to the latter being thinner and of poorer substance. Bull hides are not liked by the tanner, owing to their want of uniformity in substance, being thin in the back and thick at the shoulders and the surrounding parts called *offal*. Ox hides generally weigh from 60 lbs.* to 120 lbs., cow hides from 40 lbs. to 80 lbs., and kips from 20 lbs. to 22 lbs.

Dried Hides.—These are sometimes called "flint" hides, from their excessive hardness. It is well known that when skins are dried in the sun they become nearly as hard as horn, and when in this condition, they require much soaking, rubbing, and beating to bring them to the proper state for treatment in the lime pits. The imported dried hides of Buenos Ayres, Monte Video, and other countries are, however, extensively used by the tanner, and from them leather of very good quality is produced.

Salted Hides.—The salted hides from South America come into this country in a moist condition, a large quantity of salt being stratified between each hide. Since the salt, however, adds considerably to the weight of the hides, it is usual for the intending purchaser, when inspecting them at the docks while the vessel is unloading, to turn them over before having them weighed, to free them as far as possible from the loose salt; while doing so he

* Hides are reckoned *small*, and of less value in proportion, when they weigh 60 lbs. and under. Over this weight they rank as *large* hides.

is able at the same time to form a fair judgment as to their condition. These hides are frequently impaired by the barbarous system of *branding* adopted by the South American cattle owners, sometimes as many as half-a-dozen brands being visible on a single hide. These impressions of the branding-iron render such parts of the hide useless when tanned, whereby the manufacturer necessarily suffers loss. Unsuccessful attempts have been made from time to time to induce cattle owners to adopt some less brutal and injurious system of marking their cattle. Probably the most effectual remedy for the evil would be to reject all such heavily branded hides.

Dried Salted Hides.—The hides from Brazil, Mauritius, West Indies, and the Cape sometimes come into the market both dried and salted, in which condition they are more readily brought to a pliant state than the so-called "flint," or dry hides.

Selection of Hides.—Although judgment based upon practical experience is the only reliable guide in the selection of hides and skins, there are several points to which special attention may be directed. 1. The hide should present the appearance of having been well flayed, free from cuts or gashes produced by the slaughterer's knife, and present little or no sign of decomposition. 2. The hide should not be loose and flabby, but generally firm in substance. 3. Besides being stout in the back, or *butt*, it should exhibit this quality, though in a gradually diminishing degree, right up to the shoulder. 4. The hide should be free, or as free as possible, from *warbles* or *warble marks*, more especially if to be used in the preparation of harness, bucket, or hose leather. These defects, which are produced by the *larva*, or grub, of the *bot*, or gadfly (*œstrus bovis*), sometimes cause serious injury to the most important portion of the hide—the back; and although warbles are of less consequence in the production of sole leather, they would be fatal to leather which is required to be wind or water tight. Since the subject of warbles is a very important one, and has received much attention from entomologists and others, it may be well to consider the origin

and nature of the destructive parasites which produce the holes, or warbles, in the hides of cattle.

Warbles.—Some persons seem to have entertained the idea that the grub which perforates the skin of oxen is developed much in the same way as the *trichinæ*, from which the devourers of uncooked ham and bacon, and German sausage, suffer—chiefly in Germany—in the form of disease known as *trichinosis*. We think, however, that the most reliable evidence is in favour of the entomologists, who have universally attributed the pest to the gadfly, an insect which is well known to haunt the meadows in which cattle feed, and to cause the animals much pain and suffering. It appears to be conclusive that the gadfly first pierces the skin with an organ termed an *ovipositor*—much in the same way that a wasp's sting is introduced—and that in the hole thus formed an egg is deposited, which after a time becomes hatched. The existence of the liberated grub beneath the skin causes great irritation, and an open sore is established, which extends as the larva increases in size. When it has become fully matured, it escapes from the hole, and falls to the ground, where it in time changes to the *pupa*, or chrysalis state, from which, in the following season, the pretty but dreaded new-born fly emerges to carry on the war with the bovine race. The distinguished naturalist, Sir John Lubbock, says, "The gadfly deposits its eggs upon the bodies of animals, and the grub feeds inward when hatched." Another writer in *The World of Insects* says: "The gadfly at certain seasons attacks oxen, not to bite and suck their blood, but to deposit its eggs in the hides of the cattle—an operation which is not put into execution without occasioning considerable pain. The circular hole thus made always continues open, and increases in diameter as the larva increases in size, which thus enables a continual supply of fresh air* to reach the

* It may be doubtful whether air is really necessary to the existence of these maggots, since the *trichinæ*, tape worms, *ascarides*, and other well-known parasites seem to get on very well in the animal system without troubling themselves about a "breath of fresh air." An animal that thrives upon purulent and decomposing matter may be said to be not very particular as to "fresh air."

insect. But although they torment and terrify the cattle during the time of ovipositing, they do them in reality no material harm; indeed tanners prefer hides that have the greatest number of bot holes, considering them the strongest and best, which indeed they are, as the gadfly never attacks any but young and healthy subjects." This seems an extraordinary statement, and one which the mind cannot readily accept as based upon reasonable ground. That young and healthy animals should be preferred by the anxious parent for the boarding and lodging of her progeny is quite natural and to be applauded; but that it should be stated that tanners prefer perforated to sound hides seems inexplicable, more especially as it is so very well known that how to get rid of warbles has been one of the most anxious subjects of inquiry connected with the trade for many years.

Referring to the ox-bot or ox-gadfly, another writer observes—"It is a beautiful insect, not quite half-an-inch long, and thicker in proportion than the horse-bot. It has brown, unspotted wings, the face whitish, the crown of the head brown, the thorax black, the abdomen whitish, with a broad black band round the middle, and yellow hairs at the extremity, where also the female has an ovipositor—a remarkable organ, formed of a horny substance, consisting of four tubes, retractile within one another, like the pieces of a telescope, and the last of them terminating in five points, three of which are longer than the others, and hooked. By means of this organ, a small round hole is pierced in the hide of an ox's back, in which an egg is deposited. The fly is very quick in depositing her egg—not remaining on the back of the animal more than a few seconds. Cattle exhibit great alarm and excitement at the presence of the gadfly, and rush wildly about with head stretched forward, and tail stuck out, to escape from their tormentor. The further injury done by this insect is not, however, usually great, the larva—a little pearl-white maggot feeding upon the juices of the skin—causing a swelling, called a *warble*, forming a sort of sac, within which it lives and grows amidst a kind of purulent

matter suited to its appetite, and from which it usually emerges, leaving a small sore; and, like the horse-bot, undergoes its further transformation in the ground." Again, Miss Eleanor A. Ormerod, who had worked assiduously with the farmers in their efforts to diminish the injuries caused by insects to their crops, writes: "The *œstrus bovis* is a largish two-winged fly, and the female lays her eggs on the *backs* of horned cattle. The maggots from these, by feeding on the flesh, cause tumours, with an opening at which orifice the tail end of the maggot is usually exposed. When full fed, the *larva*, or maggot, drags itself out of the tumour and falls to the ground, where it changes to the pupa or chrysalis state, from which in due time the rather handsome fly emerges."

The above observations clearly prove the origin of warbles, and when it is borne in mind that, besides the positive injury done to the hide, the animal must suffer great and continual torture, it would be well if our agricultural chemists and scientific farmers were to devote special attention to the subject, with a view to discover some means of rendering the skin of young cattle less attractive to the gadfly. This might be accomplished, possibly, by brushing over that part of the skin (the back) which is generally selected as the depository of the gadfly's eggs, some oil, or solution of such substances as are known to be objectionable to insects, but harmless to the animals themselves. It is well known, for example, that the smell of the oil of birch is much disliked by most insects, as also is creosote, or water impregnated with it. Again, powerful bitters, as wormwood, quassia, and aloes, are repugnant to some species of insects. If, therefore, during that period of the year when the gadfly makes its appearance, the backs of cattle were brushed over with one or other of these agents, is it not probable that the fly, recognising a foreign flavour or odour upon the skin of the animal, would abandon it and fly from beast to beast in search of one more suited to its purpose? Doubtless the gadflies emerge from the shell of the chrysalis with tolerable regularity as to time, in which case the appearance of

the first insect of the season would be a signal for the application of any agent which it was desired to try with a view to determine whether a remedy for warbles could be found in the direction we have indicated.

Abusive Treatment of Raw Hides.—Ordinary carelessness and even rough usage, of a raw material so difficult to handle as the hide of such a large animal as the ox, can neither be wondered at nor prevented, but apart from this, hides are too often abused, in various ways, to such a degree as greatly to reduce their value to the tanner. Some years ago M. H. Lange, a Cordovan leather tanner, at a meeting of the trade at Oschatz, exposed the abuses to which hides were subject before they fell into the hands of the tanner; and since his observations are applicable to all times and places, their reproduction here will doubtless be acceptable to our readers.

"M. Lange expressed his regret that in the preparation of the hide for trade purposes, raw hides and skins laboured under great disadvantages, owing to the farmers' and butchers' handling, inasmuch as this was not carefully done with a view to the future operations to be undergone by the raw material. The bark and white tanners present at the meeting, also gave expression to the united wish that through making known the manipulations which experience has proved to be the most simple and at the same time the most efficacious, hides or skins may be delivered in a condition perfectly suitable to the process of manufacture, and the evils specified may hereafter be done away with as far as possible. It too often happens that hides and skins of slaughtered animals, as of those that have died from natural causes, are not at once taken off, but left for days on the carcase. This is in the highest degree detrimental to the hides, as they acquire thin and defective spots through decomposition going on in the carcase, or the worms which are forming in the interior of the animal [query] work destructively upon the hides.

"Great damage is also caused, although not of so serious a nature, if, in flaying, the work is not done with all due care. The bits of flesh and fat, which are too often allowed

to remain adhering to the hides and skins, become at once decayed and communicate decay to the skin, which is injured or eaten away in spots, becoming consequently, and subsequently, very thin, or even worn into holes. Such damage is noticeable more especially after manufacture, when the leather is found bad in appearance or pitted with dark spots, as in the case of coloured leather. Leaving these defects out of the question, the suppleness and durability of the leather itself will be injuriously affected if the skins are not suitably and carefully treated in drying and hanging up, by the premature shrinking and imperfect drying of the material. As evidence that the evils just mentioned, arising from improper treatment, are of more importance than is generally thought, M. Lange states that the sheepskins received in the summer season often yield barely one-third of the material perfectly adapted to the manufacture of imitation Morocco leather.

"In view of these evils, and in order to promote the interests of the leather trade, the following points are to be urgently recommended to the slaughterers in flaying hides and skins:—

"1. Immediately after the death of the animal the hide or skin should be carefully taken off.

"2. The fleshy or fatty portions still adhering to the skin should be detached, down to the smallest pieces.

"3. The hide should, without the least delay, be hung up in a very airy place, and one not exposed to damp, with the hair side inward, so that the draught of air may play upon the entire length of the flesh side of the hide.

"4. In order to prevent the hide from shrinking, the head and tail ends should be stretched out and nailed to the pole.

"5. The hoofs and legs should be spread with skewers on both sides.

"6. The flaying of the hide should not be entrusted to inexperienced persons; for unless a certain dexterity is brought into operation, the value of the skin will be considerably lessened. Only by observing these directions, can the skins and hides be properly dried and delivered free from defects, suitable for valuable use. The benefits

that will accrue to the whole leather trade by following such a course cannot be rated too highly, for not only will it secure a serviceable material to manufacturers, but also a large quantity of hides and skins will be saved from destruction, and the market will be better and more fully supplied. A further consequence will also be that a better manufactured article will be produced and lower prices established."—*Dussauce's Treatise.*

A few years ago Mr. George Middleton, manager of the Midland Counties' Butchers' Hide, Skin, &c., Company (Limited), suggested the plan of issuing cheques to slaughtermen, entitling them to a reward of sixpence for each hide taken by the company flayed to its satisfaction. In addition to this, the master butchers agreed to give an extra sixpence per hide, as a reward for careful flaying, thus giving the slaughtermen one shilling per hide for performing their work with extra, that is proper, care.

Kips, or skins of the younger and smaller animals, are largely imported from the East Indies, the Cape, Australia, North and South America, and elsewhere. From the East Indies they arrive either *dry, dry salted,* or *brined*—that is, simply salted. The E. I. kips are the skins of a small breed of oxen, and being derived from full-grown animals they are in reality *hides.* Besides being imported in either of the above conditions, a large quantity reach our market in the tanned state. The importation of E. I. kips amounts to millions of skins annually. Kips are also imported from the countries surrounding the Baltic, but these are generally obtained from animals slaughtered when young, and therefore are more of the character of skins than hides. The smaller and inferior varieties of kips and calfskins are tanned for the purposes of the bookbinder and glover, and also in the preparation of leather for uppers of the lighter kinds of boots and shoes.

Buffalo Hides.—These are imported from various parts of the East Indies—as Bombay, Calcutta, Batavia, Kurrachee, &c. These hides make an inferior kind of sole leather, and are tanned in the same way as ox hides. For

certain purposes, however, they are tanned in a peculiar manner, and then form what is known as *buff*, or *belt leather*, which possesses superior strength to the same article prepared from cow hides. The annual importations have sometimes amounted to upwards of 300,000 hides.

Horse Hides.—The best horse hides are those which are imported from the River Plate, Rio Grande, and other parts of South America. The wild horses of the pampas, which are captured and slaughtered chiefly for the hides and fat, furnish a vast supply of hides, which are greatly superior to those of our own market, which are generally from old and worn-out animals. The skin of the horse is much inferior to that of the ox, or even cow, as to strength, texture, and thickness, and is therefore not suitable for making sole leather; a small portion of the back, or butt, nearest the animal's rump, however, is generally cut away, and when tanned is employed for upper leather ("crup"). The better qualities of horse hides are tanned for *uppers* of boots and shoes, but the chief purpose to which they are applied is in making *Cordovan*, or enamelled leather. For this purpose the pelts are split by machinery, which reduces them to any required thinness. These hides are also *tawed*, or alumed, and converted into *white leather* for workmen's aprons, for the thongs of common whips, and other useful purposes.

Ass and Mule Hides.—When tanned, these hides form what is known as *Shagreen*, or *Shagrin*.

Hippopotamus Hides.—Only a limited number of these skins come into the market, being imported from the south of Africa. They are of remarkable thickness, and when tanned are exceedingly hard. The principal purposes to which the tanned hides are applied is for implements used in washing and bleaching cotton and linen goods, and for making circular "buffs" for polishing brass and other metals. Walrus hides are also used, when tanned, for similar purposes.

Calves' Skins, of home produce, are of very superior quality, and, when tanned with oak bark, produce a leather which is very extensively used for the *uppers* of

shoes and for boot fronts. In France, which is famous for the excellence of its calf-skin leather, the calves are slaughtered when about five or six months old.

Sheep Skins.—The supply of sheep skins in the home market is very extensive, and besides this source of supply an immense number are imported from South America, the Cape, Australia, and many other countries: a very considerable proportion come to us in the tanned state. Although sheep skins produce but a very weak, spongy leather, they are applied to a great variety of purposes. When tanned with bark, they constitute *bazils*, and are used for making slippers, and also as bellows-leather; when *tawed*, or prepared with alum and salt, they form what is termed *white leather*, which is much used by druggists, and also for workmen's aprons. Sheep skins are very often subjected to the operation called *splitting*, when the grain side is tanned with sumac, and dyed, and is afterwards worked up as *imitation morocco*, *roan*, or *skiver*, into covers for pocket-books, for hat linings, &c. The flesh side is converted into white leather for druggists' use, or into *chamois*, or *shammy leather;* for the former, however, lamb skins are most generally employed. Sheep skins are sometimes tanned with the wool attached, and converted into mats; or tawed, and made into *housings*. For these purposes the best skins are selected, and those with the longest and most beautiful fleece are chosen by preference.

Lambs' Skins are very extensively used in the preparation of leather by the process of *tawing*, for glove-making, as a substitute for kid leather, and for various other purposes. Besides the very large number produced in this country, great quantities of lambs' skins are annually imported. There is a great difference in the quality of these skins; those from the animals slaughtered shortly after birth possess an exceedingly fine grain and are susceptible of a very uniform dye—an important feature in skins used for ladies' gloves. This extreme delicacy of texture is retained by the skin of lambs until after they are a month old, from which period they gradually lose it. In the south of France and in Italy considerable numbers

of lambs are killed averaging four weeks old; leather prepared from these skins is largely used for "kid" gloves.

Goat Skins.—A very extensive trade is carried on in Great Britain and Ireland in these skins, and also in the tanned and tawed leather produced from them. In Ireland a large number of skins of native produce are used, but Great Britain is supplied chiefly by imports from Switzerland, and the Valley of the Rhine, and also from India and the Cape of Good Hope, from which latter places they are imported in the dry state. Millions of these skins, however, come into the British market already tanned and tawed from these countries. The Swiss goat skins are most highly esteemed, owing to the very fine, close and uniform texture of the grain, which enables the dyer to impart a brilliant and permanent colour; the leather prepared from Swiss skins is said to be stronger and more durable than any other manufactured from goat skins. A very considerable number of these skins are annually converted into morocco leather for various uses in the different branches of the trade. The goat skin tanned and dyed on the grain side constitutes *true* morocco leather. Mogadore skins are made into a kind of black morocco, called *Cordovan*, in consequence of the first supplies of the article being obtained from Spain and Cordova, where the Moors originally brought the manufacture to great perfection. The sound skins which arrive from the Cape of Good Hope, are much larger and superior in strength and thickness to any other variety. East India skins are small and light, and are generally converted into chrome leather chiefly used for ladies' shoes. Those from Mexico, known in the American market as *Tampico* skins, bear a very high character. Compared with sheep skins, those of goats are much superior in texture, strength, and durability. Goat skins are occasionally prepared so as to imitate chamois leather, and applied to most purposes to which the latter is adapted; and likewise with the hair on, and used for matting.—*Muspratt.*

Kid Skins, converted into leather by the process of tawing, are very extensively used in the manufacture of

gloves, and also for slippers, or light shoes; by druggists for covering the corks of bottles, and for other useful purposes. The kid skins of France—from which the famous "French kid" gloves are made—have always been held in high estimation, as also are those of Ireland. After the animal begins to feed upon herbage, the skin loses in delicacy of texture, and therefore becomes unsuited for the finest gloves. There can be no doubt whatever that from the time the young animal ceases to derive its sustenance from the mother, and feeds upon vegetable substances, a greater degree of solidity and firmness of texture is acquired by the skin, as also by all other parts of the body, and as a consequence the elasticity and extreme fineness and delicacy in texture of the skin gradually become deteriorated.

Hog and Pig Skins.—The practice of skinning swine is carried on in Scotland, and also on the Continent, and the skins, when tanned, form a very light and porous, but still very tough and durable leather, which is extensively used by harness makers, and also for the seats of saddles. On the Continent the hide is dressed with the hair on, and is employed for covering portmanteaus, knapsacks, &c. Pig skin is also used for leather breeches, but not to such an extent as formerly.

Seal Skins.—These valuable skins are imported into this country in very considerable quantities, from British North America, Newfoundland, the United States, the Whale Fisheries, Norway, the Cape of Good Hope, and other localities. The skin of the seal is light, and of very close texture, and when properly tanned is considered to produce a leather of greater strength in proportion to its weight than any other kind of leather. Seal skins are commonly made into black enamelled leather, for ladies' shoes and boots, and the stouter varieties are used for the uppers of hunting and riding boots, knapsacks, &c. Seal skins are frequently merely dressed, with the fur on, for ladies' jackets and muffs, and various articles of clothing, as waistcoats, caps, &c.

Deer Skins are much used for making gloves and cha-

mois leather, and are prepared by the tawing process, in the same manner as sheep and goat skins. The chief manufacture in connection with deer skins is carried on in the United States, and is comparatively unimportant in this country.

Porpoise Skins.—These skins are now being much used for uppers of boots, for which purpose they are admirably suited, since, when tanned, they yield a very supple and durable leather. Round and flat laces prepared from these skins are exceedingly tough and strong. In Canada the skins of the white porpoise have been tanned into leather, which is said to be soft, strong, and of a beautiful finish.

Serpent and Crocodile Skins.—During the past few years specimens of tanned serpent skins have entered the market, as also those of the crocodile and alligator, and at the period at which we are writing, reticules, purses, and bags formed of crocodile and alligator skins are freely exposed for sale. Indeed, so great is the demand for this variety of ornamental leather that close imitations of the various skins are produced by means of the electrotype process. (See page 432.)

CHAPTER IV.

TANNIN OR TANNIC ACID.

Tannin or Tannic Acid.—Preparation of Tannic Acid. Pelouze's Process.—Berzelius' Process.—Bouillon-Legrange's Process.—Merat-Guillot's Process.—Dizé's Process.—Deyeux's Process.—Proust's Process.—Serturner's Process.—Schering's Process.—Badvil and Lienders' Process.—MM. Coëz's Process.—Kohlrausch's Process.—Properties of Tannic Acid.—Parnell's Views.—Pure Tannic Acid.—Reactions of Tannic Acid.—Table of the Percentage of Tannin in Vegetable Substances.—Morfit's Observations.—Artificial Tannin.

Tannin, or Tannic Acid. — This powerful astringent vegetable principle, which is also known by the names of *Tan* and *Gallo-tannic acid*, exists in those excrescences called *Gall nuts*, which are found upon certain varieties of oak, and some other plants, as the Tamarisk. It also occurs in a great number of trees and plants. Galls are formed by the female of the insect *Cynips* (or *Diplolepsis*) *Gallæ tinctorum*, piercing the buds of a species of oak named *Quercus infectoria*, and there depositing its eggs. These producing irritation, cause the juices of the plant to flow towards the wound, and the subsequent enlargement of the part, in the form of a vegetable tumour, or gall, round the larva. This grub, when fully developed, escapes by a hole which it perforates in the gall. The *Quercus infectoria* is the principal species of oak which yields the nut-galls of commerce.

Preparation of Tannic Acid. Pelouze's Process.— By this process, tannic acid is obtained by means of a percolator, *a* (Fig. 2) fitted into a receiver *b*. The percolator is a cylindrical glass vessel, open at both ends, the upper opening being fitted with an air-tight stopper, and the

lower end adjusted to the neck of the glass receiver *b*. The upper vessel, or percolator, is about half filled with coarsely-powdered galls, which are prevented from falling through the lower opening by a plug of cotton, and the powder is then covered, in successive portions, with ether, which has been previously shaken up with a little water.* The stopper is now inserted in the mouth of the percolator, and the mixture allowed to digest for several hours, after which the stopper is withdrawn, and the liquid allowed to filter into the receiver beneath. When all the liquid has passed through, the powdered galls are washed with more ether introduced at the top as before. After standing for a short time, the filtered liquor will be found to separate into two distinct strata, of unequal density. The tannic acid and gallic acid, being both extracted by the mixture of ether and water, now separate; the lower stratum being a solution of tannin (generally of an amber colour) in water, and the upper stratum an etherial solution of other substances contained in the galls, the most important of which is *Gallic acid*. The two solutions are next separated; the aqueous solution of tannin is gently evaporated to dryness and finally exposed to an oven heat, at a temperature not exceeding 212° Fahr. The result is an amorphous, or uncrystallised mass of tannin, nearly if not quite pure, the yield being frequently about 40 to 45 per cent. of the weight of galls used. The ether in the lighter liquid is recovered by distillation, over a water bath, with the aid of a Liebig's condenser, supplied with ice-cold water.

Fig. 2.

Berzelius' Process.—A hot infusion of galls is first

* It is absolutely necessary that the ether should be agitated with water, otherwise not a fraction of tannin will be obtained.

obtained, and to this is added a few drops of sulphuric acid. The mixture is to be well agitated, then filtered, and to the filtered liquid sulphuric acid, diluted with its own weight of water, is added gradually, until the precipitate formed, after standing for an hour, is found in the form of a semi-fluid gelatinous mass. The liquid is then decanted and carefully mixed with *concentrated* sulphuric acid so long as a precipitate forms. The precipitate is then washed with water strongly acidulated with sulphuric acid, and is then pressed between the folds of bibulous (filtering) paper. The precipitate is next dissolved in *pure water*, and to the solution *carbonate of lead*, in very fine powder, is added, and after agitation and maceration for some time, until the *sulpho-tannate* is all decomposed, the mixture is again filtered, and the liquid gently evaporated to dryness. The residuum is finally powdered and digested in ether, which is now allowed to evaporate spontaneously, and the resulting powder is at once bottled to preserve it from the air.

Bouillon-Legrange's Process.—By this method, an infusion of nut-galls is precipitated by carbonate of ammonia. The precipitate is afterwards washed with cold water, and then digested repeatedly in fresh quantities of alcohol at 0·817. This process, however, does not yield pure tannin.

Merat-Guillot's Process.—An infusion of nut-galls is precipitated by lime water, and the precipitate treated with dilute nitric or hydrochloric acid. Effervescence occurs, and the liquor assumes a dark brown colour. After filtration, a bright black substance separates, which the inventor assumes to be pure tannin, but according to Sir H. Davy it is combined with vegetable extractive and a certain portion of lime.

Dizé's Process.—This process consists in pouring concentrated sulphuric or hydrochloric acid into a concentrated infusion of nut-galls, when a white precipitate is produced, which Proust believes to be a combination of tannin with the acid employed. It is purified by washing with cold water, then dissolved in warm water, and the

acid is saturated with carbonate of potash. This process does not produce *pure* tannin, but a substance in which both gallic acid and extractive are present.

Deyeux's Process.—By this method, a strong infusion of galls is precipitated with a concentrated solution of carbonate of potash, when an abundant yellowish-white precipitate is formed, which on drying yields a whitish powder. The product, however, is not pure, as proved by Davy and Tromsdorff, who found it to be a combination of tannin, gallic acid, carbonate of potash, and lime.

Proust's Process.—To an infusion of nut-galls is added a solution of chloride of tin until the precipitate of tannate of tin ceases to fall. A yellowish-white precipitate is formed, which is afterwards washed and mixed with cold water. A current of sulphuretted hydrogen gas is then passed through the product, which is next filtered and then evaporated to dryness. Although a tolerably pure product is obtained, the presence of gallic and hydrochloric acids and extractive in small quantities have been traced.

Serturner's Process.—By this process an alcoholic infusion of nut-galls is precipitated by warm carbonate of potash. After decanting the liquid, the residue is washed with alcohol, and then treated with sulphuric acid. This is then evaporated, and the residue treated with alcohol. The excess of sulphuric acid is precipitated by carbonate of lime. After filtering, the filtrate is evaporated to dryness, when tannin containing very little gallic acid is the result.

Schering's Process.—This is called, by the patentee, the "manufacture of improved tannic acid." The thick extract, or solution of tannin, whether it be combined with water, alcohol, or ether (!) is placed in a heated chamber, the heat being maintained and regulated at a low temperature, and the air excluded as far as possible. The extract or solution is thus slowly evaporated, until it is reduced to a thick pasty condition. It is then forced by a pressing apparatus through a plate perforated with small holes, from which it exudes in thin filaments, like thin

vermicelli threads; these are wound, as they exude, on suitable reels, or cylinders, or they may be collected in any convenient manner. The threads so obtained, on cooling, are very brittle, and will break up into golden, shining, needle-like fragments, which can be readily collected, and preserved in bottles.

Badvil and Lienders' Process.—The object of this invention is to obtain "tanning material from the asphodel plant," and is based upon the discovery that this plant contains tannin which does not dissolve under the influence of acids and fermentation, and which is not assimilable, being diffused or mixed with a large proportion of water, saccharine matter, and other substances. To render the tannin "adaptable for leather dressing like the best sumacs, it is necessary to eliminate the main portion of the water and saccharine matter." For this purpose the asphodel is washed, to free it from the earth which may adhere to it; it is then grated or crushed to break up the cells, and the pulp thus obtained is then pressed. The juice which flows from it is subjected to a complete fermentation, to extract its alcohol. The pressed pulp, which contains nearly all the tannin, is dried, preferably by exposure to the sun, and finally reduced to a powder or extract. "It can be used in this state for leather-dressing purposes."

MM. Coëz's Process.—The tanning matter or juices being extracted by the usual processes, the decoctions are placed in wooden vessels, in which they are intimately subjected to the process of decoloration in the following manner:—Oxalic acid is first added in the proportion of one grain of acid to every 100 litres * of juice, the density of which is unimportant, for the purpose of saturating the lime which is contained in the water used in the process of extraction, in proportions varying according to the quality of the said water. After allowing a few minutes for the oxalic acid to act, gelatinous alumina is introduced in the proportion of about 250 grains per 100 litres of juice, and

* 1 litre is equal to 34 fluid ounces nearly, or about six ounces less than an Imperial quart.

per degree of the density. The materials are now vigorously agitated, and the mixture being immediately filtered, the alumina remains upon the filter with the colouring matter. The clear tannic liquid, from which the colouring matter has thus been removed, is collected and evaporated *in vacuo* by known means, and brought to a density of about 20° Baumé. The tannic extract obtained by this process is said to be remarkably pure, is soluble, and readily assimilable by hides or skins.

Kohlrausch's Process.—This process, which is also applicable to the extraction of colouring matters from dye-woods, consists in first reducing the wood or bark by cleaving, breaking, sawing, &c., to small pieces about $\frac{1}{2}$ inch to 3 inches long, about the same width, and from $\frac{1}{20}$ to $\frac{1}{2}$ inch thick. These pieces are placed in closed vessels of copper or enamelled iron, and treated with water at about 20 to 75 C. (68° to 167° F.), under pressure, so as to extract tannic acid, &c., the different vessels forming a "continuous working battery," and being connected with each other by pipes, which may be heated if desired. If, for instance, the "battery" consists of twelve vessels, pure water, under pressure, is allowed to enter the first vessel, where the process begins, and is continued until the densities of the liquids inside and outside the bark-cells are equalised. The liquid is afterwards allowed to pass from the first into the second vessel, where the tannic acid solution will become more concentrated. From the second vessel the liquid passes into the third, and so on up to the eleventh vessel, where the concentration of the liquid is almost equal to that in the cells containing the raw materials. During that time, pure water has been supplied to the first vessel, by which its contents become exhausted and may be discharged. Pure water is now admitted to the second vessel, and the twelfth filled with raw material. The extracted liquid is afterwards made to pass into the twelfth vessel, the first filled with raw material, the second discharged, and pure water allowed to flow into the third vessel, and so on, in such a manner that the contents of ten

vessels are continuously subjected to *dialysis*.* The necessary temperature of the water may be maintained by providing the connecting pipes with heaters of any suitable construction. The extract obtained by this process may be further concentrated in vacuum pans, or may be employed directly for the manufacture of leather.

Properties of Tannic Acid.—This acid, as it exists in different vegetables, varies in its chemical reactions, sometimes in a very marked degree. According to Gmelin, the following plants contain the modification of tannin which renders solutions of peroxide of iron (as the persulphate of iron for example) a *deep blue* :—Galls, the *roots* of *Lithrum salicaria*, *Geum urbanum*, and *rivale*, *Potentilla argentea* and *anserina*, *Arctium lappa*, *Sanguisorba officinalis*, *Poterium sanguisorba*, *Alchemilla vulgaris*, *Polygonum bistorta*, *Iris pseudacorus*, *Nymphæa alba*, the *wood* of the oak, and many other trees, the *bark* of different species of oak, the leaves of oak, *Uva ursi*, and many others, the *twigs* of the black currant and sumac, the *petals* of pomegranate, *Rosa gallica* and *Pæonia officinalis*. The tannin which gives a *green* precipitate with persalts of iron is found in *Catechu* and *Kino*, in the roots of the *Tormentilla erecta*, *Potentilla reptans*, *Rosa canina*, *Rheum rhaponticum*, &c., in the different species of *Cinchona bark*, in *Cinnamon*, *Cassia*, and in horse-chestnut bark; in the leaves of *Salvia officinalis*, *Lamium album*, *Glecoma hederacea*, &c., in the varieties of *tea*; in the flowers of *Tilia Europæa*, *Centauria cyanus*, and *Arnica montana*; in horse-chestnuts, date-stones, &c.

* In practical chemistry, the method of separating substances by "diffusion," through a hoop covered with parchment paper, is called *dialysis*. When a solution having a higher specific gravity is introduced into a cylindrical glass vessel, and water then very cautiously poured into it in such a way that the two layers of liquid remain unmoved, the substance dissolved in the lower liquid will gradually pass into the supernatant water, though the vessel may have been left undisturbed, and the temperature remain unchanged. The gradual passage of a dissolved substance from its original solution into pure water takes place notwithstanding the higher specific gravity of the substance which opposes this passage; this is called "diffusion of liquids," the investigation of which was due to the late Professor Graham, of the Royal Mint.

According to the experiments of Berzelius and others, the tannin in all plants is essentially the same substance, the different colours of the various precipitates with persalts of iron depending on the accidental presence of impurities, and also on the nature of the salt of iron used. But the more recent researches of Dr. Stenhouse favour the conclusion that not only must the tannins of different plants which produce different coloured precipitates in the same solution of peroxide of iron be regarded as distinct substances, but even that some of the varieties of tannin which agree in their reaction upon salts of iron, and in their general chemical habitudes, are by no means identical.* Dr. Stenhouse availed himself of a new test for tannin, which affords indications only with the variety of tannin contained in galls, and with gallic acid, which consists in the production of pyrogallic acid, when the body to be tested is subjected to destructive distillation: pyrogallic acid is disengaged as a crystalline sublimate.

Parnell's Views.—This chemist observes: "Although the astringent matter contained in several vegetables is designated by the same name, tannin, or tannic acid, yet all these bodies do not appear to be identical. The differences, however, which are perceptible in the properties of most of the substances which are thus classed together are small, and seemingly of no great importance in the practical application of this vegetable principle. Other vegetable matters exist, the properties of which amply distinguish them from tannin. The most characteristic properties of tannin are, astringency in taste, and the power of being precipitated from its aqueous solution, either of a bluish-black, or dark green colour, by a solution of the peroxide of iron, and of a dirty white, or

* It is now generally recognised that although the numerous varieties of tannin all possess the common property of precipitating gelatine, not only do they differ greatly in their chemical reactions, but the leather produced from them is of very varied character—sometimes of very indifferent quality; and were it not for the custom of mixing certain tanning materials with others of known excellence, it is doubtful whether some of them would not be altogether abandoned.

brown colour, by a solution of gelatine. The precipitate produced in a solution of a persalt of iron, which is the *tannate* of peroxide of iron, is the basis of common writing ink. A solution of *protosulphate of iron* (*copperas*), perfectly free from all peroxide of iron, experiences no immediate change on the addition of tannin; but the mixture instantly becomes deep blue or black on exposure to the air, through the absorption of oxygen, and formation of peroxide of iron. If cold aqueous solutions of tannin and animal gelatine (glue, bone-size or isinglass), are mixed in certain proportions, both of these bodies are almost completely thrown down as a precipitate, known by the name of *tanno-gelatine*, which generally contains about half its weight of tannin. Sometimes, particularly when heat is applied, or when the acid is in excess, the precipitate forms, on stirring, a very viscid and elastic mass, somewhat resembling caoutchouc. In its chemical condition, tanno-gelatine is quite analogous to leather, and was at one time, in fact, generally regarded as that substance in a pure state. This cannot be the case, however, as gelatine does not exist ready formed in the skin (according to Berzelius) and tanno-gelatine, unlike leather, is slightly soluble in water at the boiling point. The aqueous solution becomes turbid on cooling, owing to the re-precipitation of the tanno-gelatine. This compound may also be dissolved by an excess of a solution of gelatine, but not by an excess of a cold solution of tannin. When dried, it loses its viscidity and elasticity, and becomes brittle and pulverulent."

Pure Tannic Acid is nearly colourless, inodorous, pre-eminently astringent in taste, uncrystallisable, very soluble in water, and less soluble in pure alcohol and ether. Its aqueous solution reddens litmus, and decomposes the alkaline carbonates, with effervescence. It combines energetically with gelatine; when, therefore, a piece of skin or bladder is immersed in its aqueous solution, the tannic acid is entirely abstracted; whereas, if *gallic acid* were present, that acid remains dissolved in the water. Tannic acid also furnishes an abundant white precipitate

in solutions of isinglass or glue. A concentrated aqueous solution of tannic acid is precipitated by hydrochloric, nitric, sulphuric, phosphoric, and arsenic acid; but not by oxalic, tartaric, lactic, acetic or citric acid. By the prolonged action of acids and alkalies, tannic acid undergoes various, and often complicated, changes, amongst which its conversion into gallic acid is the most common. —*Brande.*

By exposure to the air, a solution of tannic acid gradually becomes turbid, and deposits a grey crystalline powder, which is *gallic acid.* By contact with the air oxygen is absorbed, and an equal volume of carbonic acid is evolved; only a portion of the tannic acid, however, is thus decomposed, and is converted into *gallic* and *ellagic acids.* It is the opinion of many, that the gallic acid present in gall nuts is due to the absorption of oxygen by the tannic acid, during the process of vegetation. And to this end, possibly, the insect which inhabits the gall nut during its development, may be the real active agent.

Reactions of Tannic Acid.—The following reactions of tannic acid are given by Abel and Bloxam*:—

Concentrated sulphuric acid, treated with (solid) tannic acid, produces, immediately, a dark, purplish-black liquid, but does not evolve carbonic oxide.

When heated on platinum, tannic acid burns, chars, and emits a peculiar odour.

Alkalies, added to a solution of tannic acid, cause it to absorb oxygen from the air, and to assume a *brown colour.*

Sesquichloride of iron produces a bluish-black precipitate of *tannate of sesquioxide of iron.*

Dilute sulphuric (or hydrochloric) acid produces, in a pretty concentrated solution of tannic acid, a *white precipitate*, which is an insoluble compound of the two acids.

Tannin is precipitated from a tolerably strong solution of the mineral acids, and these precipitates consist, according

* "Handbook of Chemistry." By F. A. Abel and C. L. Bloxam.

to Berzelius, of compounds of tannin with the acids respectively. If the compound with sulphuric acid be boiled for a few minutes in dilute sulphuric acid, the tannin becomes converted into gallic acid, which is deposited in coloured crystals on cooling. When the sulphuric acid employed for this purpose is diluted with 7 or 8 times its bulk of water, the crystals of gallic acid are colourless and nearly pure. A similar change occurs according to Liebig where the compound of tannin and sulphuric acid is boiled with an excess of caustic alkali; and the action of hydrochloric acid on tannin is quite the same as that of sulphuric acid.—(*Stenhouse.*) In these cases of the conversion of tannin into gallic acid, the action of the air is unnecessary.

TABLE OF THE PERCENTAGE OF TANNIN IN VEGETABLE SUBSTANCES.

Substance.	Per Centage of Tannin.	Authority.
Catechu, Bombay	55·0	Davy.
„ „ light colour	26·3	Mulligan.
„ Bengal	44·0	„
„ Peru, dark brown colour	46·8	„
Rhatany root	42·6	Peschier.
„ „	38·3	Gmelin.
Kino—Tannin and Extractive	75·0	Vauquelin.
Butea Gum	73·2	E. Solly.
Nut Galls, Aleppo	70·0	Crookes.
„ Chinese	74·0	„
„ Istrian	24·0	Rhodes.
Old Oak, white inner bark	21·0	Cadet de Gassincourt.
„ „	14·2	Davy.
Young Oak, white inner bark	15·2	„
„ coloured, or middle bark	4·0	„
„ entire bark	6·0	Davy and Geiger.
„ spring-cut bark	22·0	Davy.
Oak, Kermes, bark of the root	8·9	Davy and Geiger.
„ 100 years old	8·5	Muller.
„ young	13·8	„
„ British 50 years old	8·9	Mulligan and Downing.
„ Coppice	12·5	„
„ Irish 45 years old	9·50	„
„ Belgian	8·3	„
Terra Japonica, or Gambier	44·0	Eisenbeck.
Avens root, *Geum urbanum*	41·0	Tromsdorff.
Squill, bulb	24·0	Vogel.
Statice of South Carolina	12·4	Parrish.

Substance.	Per Centage of Tannin.	Authority.
Birch bark	1·6	Davy.
,,	1·4	Biggers.
Beech bark	2·0	Davy.
Larch bark	1·6	,,
Hazel bark	3·0	,,
Chestnut, American rose	8·0	Cadet de Gassincourt.
,, Carolina	6·0	,,
,, French	4·0	De Fontenelle.
,, Spanish, white inner bark	1·3	Davy.
,, ,, coloured or middle bark	0·3	,,
,, ,, entire bark	0·5	,,
,, horse	2·0	De Fontenelle.
Lombardy Poplar	3·5	,,
Blackthorn	3·3	Davy.
Ash bark	3·3	,,
Sassafras, bark of the root	58·0	Reinsch.
Elm bark	2·9	Davy
Sumac, Sicily	24·0	Crookes.
,, Malaga	16·4	Davy.
,, ,,	10·4	Franck.
,, Carolina	5·0	Cadet de Gassincourt.
,, Virginia	27·0	Anon.
,, ,,	19·5	Muller.
Willow, Leicester, white inner bark	16·0	Davy.
,, ,, coloured or middle bark	3·0	,,
,, ,, entire bark	6·8	,,
,, ,, ,, ,,	3·9	Mulligan and Downing.
,, ,, bark of the trunk	1·4	Biggers.
,, weeping	16·0	Cadet de Gassincourt.
Sycamore bark	16·0	,,
,, ,,	1·4	Biggers.
Elder	2·3	Davy.
Plum tree	1·6	Biggers.
Cherry tree	24·0	Cadet de Gassincourt.
,, ,, Cornish	19·0	,,
Tormentil root	46·0	,,
Cornus sanguinea of Canada	44·0	,,
Alder bark	36·0	,,
Hemlock	13·9	Mulligan and Downing.
Divi divi	50·0	Crookes.
,,	49·2	Muller.
Valonia	34·7	Mulligan and Downing.
Myrobalans	35·0	Crookes.
Mimosa bark	17·8	Mulligan and Downing.
,, ,,	31·1	Muller.
Apricot bark	32·0	De Gassincourt.
Pomegranate	32·0	,,
Bohemian olive	14·0	,,

Substance.	Per Centage of Tannin.	Authority.
Tan shrub, with myrtle leaves.....	13·0 ..	De Gassincourt.
Service tree, bare, June berry	18·0 ..	,,
Cloves	15·0 ..	Davy.
Winter's bark.....	9·0 ..	Henry.

The more recent methods of estimating tannin which have been introduced since the foregoing determinations were arrived at, render it advisable that the percentage in this Table should be received with caution; at the same time it must be admitted (owing to the difference which exists between tannins obtained from different sources), that even the more modern determinations of this substance are not wholly reliable.

Morfit's Observations.—1. That tannin is never found to any extent in the interior of the trunk of trees. 2. That it does not exist in poisonous plants, nor in those with a milky or viscid sap. 3. That its proportion is greater in young than in old plants. 4. That the tannin is converted into bitter principle, as the plant increases in age. 5. That it is most abundant in the cortical layers of the bark, and is usually absent altogether in the epidermis. 6. That the proportion of tannin in bark varies with the season, decreasing as the severity of the winter increases, and 7. That the two extremes of the quantity are attained in winter and spring.

Artificial Tannin.—According to Hatchett,* a substance having some of the characteristics of tannin, and to which the name *artificial tannin* has been given, may be formed by digesting charcoal in dilute nitric acid for several days. The charcoal is at length dissolved, and a reddish-brown liquor is obtained, which yields, after careful evaporation, a brown glossy substance, amounting to about 120 parts, from 100 parts of charcoal. This artifical tannin differs in one particular from natural tannin, namely, that it resists the action of nitric acid, which decomposes all varieties of natural tannin, though some are more capable of resisting its action than others. Artificial tannin has a somewhat

* *Philosophical Transactions*, 1805–6.

bitter, astringent taste, is soluble in water, and forms an insoluble precipitate in solutions of animal gelatine, consisting, according to Hatchett, of

Artificial tannin.....	36
Gelatine.....	64
	100

Hydrochloric and sulphuric acids produce brown precipitates in solutions of artificial tannin, which are soluble in hot water. A variety of artificial tannin may be formed by digesting camphor and resins in sulphuric acid, until the liquor becomes black, and on being poured into water deposits a black powder, which being digested in alcohol yields a brown matter, soluble in water, and which produces an insoluble precipitate with gelatine.

CHAPTER V.

GALLIC ACID.

Gallic Acid.—Preparation of Gallic Acid from Galls.—Scheele's Method.—Liebig's Method.—Graham's Method.—Pharmaceutical Methods.—Properties of Gallic Acid.—Pyrogallic Acid.—Ellagic Acid.

Gallic Acid.—The frequency—nay almost constancy—with which gallic acid is associated with the great astringent tanning principle,—tannic acid,—and the ready conversion of the latter into the former, by the influence of oxygen, renders it advisable that it should be considered apart from its associates, more especially since this vegetable acid often plays an important though an objectionable part in the process of tanning. Gallic acid was discovered by Scheele, and various methods of obtaining it in a pure state were afterwards devised by Deyeux, Braconnot, Liebig, and Dr. Stenhouse. The conversion of tannic acid into gallic acid by the agency of oxygen was first demonstrated by Pelouze; and the existence of the latter acid, independent of tannic acid, in several vegetables, has been proved both by Dr. Stenhouse and Robiquet. Since this acid, however, is almost always associated with tannic acid in the various plants which yield these substances, and moreover exists in much smaller proportions than the tanning principle—often a mere trace—it may not be unreasonable to infer that the existence of gallic acid is due to the oxidation of the tannic acid generated or secreted by plants, and that it is not formed in nature as a separate and distinct substance. This view is supported by the readiness with which tannic acid combines with oxygen, when exposed to the air under certain

conditions, as we find when considering its mode of preparation from gall nuts.

Preparation of Gallic Acid from Galls.—The process recommended by Dumas is as follows: A quantity of nut-galls are reduced to powder, and this is next made into a paste with water; in this state, the mass is exposed to the action of the air, in a warm situation, the temperature being from 70° to 80° Fahr., for two or three months, more water being added from time to time, to make up for that which is lost by evaporation. At the end of the above period, the mouldy, dark-coloured mass is strongly pressed in a cloth, and the solid portion boiled in a considerable quantity of water.* The solution is to be filtered *whilst hot*, and on cooling, crystals of gallic acid will deposit at the bottom of the vessel. These crystals are afterwards to be well drained, and pressed between folds of white blotting paper, and they are next to be purified, by boiling them with about one-sixth of their weight of *prepared animal charcoal* in eight parts of water. The solution is to be again filtered whilst hot, and the clear liquor set aside to cool, when pure crystals of gallic acid will be obtained, which must be well drained and dried over a water-bath.

Scheele's Method.—A *filtered* decoction of galls is exposed to the air for some months, in an open vessel; after a time it grows mouldy, and becomes covered with a thick glutinous pellicle, or scum; in two or three months the sides of the vessel, and under portion of the pellicle, are found to be covered with small yellow crystals of gallic acid, which may be purified as above.

Liebig's Method.—To a strong aqueous solution of *tannic acid*, sulphuric acid is added so long as a precipitate falls; the powder is collected, washed and dissolved by heat, in *dilute sulphuric acid;* the solution, after boiling for a few minutes, and then being allowed to cool, deposits abundant crystals of gallic acid.

Graham's Method.—A *strong infusion* or *decoction* of

* Gallic acid is soluble in 100 parts of *cold* water, and in 3 parts of *boiling water.*

galls is precipitated with *sulphuric acid* in the cold; the resulting thick mass is mixed with cold *dilute* sulphuric acid, and the liquid pressed out. The "marc" is next treated with sulphuric acid, diluted with twice its weight of water, and after boiling the mixture for some minutes, the whole is set aside to cool; the resulting crystals are purified with animal charcoal, as before.

Pharmaceutical Methods.—The Dublin *Pharmacopœia* gives two methods of preparing gallic acid, one of which is based upon the process of Dumas, or Scheele, and the other on that of Graham or Liebig. 1. Galls, in coarse powder, 1 lb.; make into a stiff paste with water, and place in a porcelain dish, and expose in the moistened condition for six weeks. The solution of the first crop of crystals is made in 10 fluid ounces of *boiling water*, and then filtered. When the filtrate (the filtered liquor) has cooled down to 80° Fahr., it is to be poured off from the crystals which have formed, and the crystals are to be washed with *ice-cold water*, 3 fluid ounces, and then drained and dried—first on blotting paper, and finally by steam or water heat. By boiling the undissolved portion of the galls with 45 fluid ounces of fresh water, more crystals are obtained. 2. One pound of powdered nut-galls are steeped for 24 hours in 1 pint of water, and after being placed in a porcelain displacement apparatus, are treated with one and a half pint of water, added in successive portions; 5 fluid ounces of oil of vitriol, diluted with an equal bulk of water and allowed to cool, is then added to the percolated infusion, and when thoroughly mixed, the liquid is filtered from the precipitate which forms. Oil of vitriol 5 fluid ounces diluted with an equal bulk of water as before, is now added to the filtrate; the precipitates, enveloped in calico, are submitted to powerful pressure, and subsequently dissolved in a solution composed of oil of vitriol 16 fluid ounces, and water 56 fluid ounces. The solution is then boiled for 20 minutes, and set aside for a week, at the end of which time the deposit which forms is dissolved in *three times* its weight of *boiling water*, and the solution treated as before.

Properties of Gallic Acid.—Pure gallic acid assumes the form of white or nearly colourless feathery crystals of a beautiful silky lustre; the commercial acid, however, is usually of a pale yellow colour; it is soluble in alcohol, and also, sparingly, in ether; its solution in water undergoes decomposition when exposed to the air. When strongly heated, gallic acid is converted into *meta-gallic acid*, or into *pyrogallic acid*, according to the way in which the heat is applied. Gallic acid is distinguished from tannic acid by *not* precipitating gelatine from its solution,* and by not affecting the *proto*-salts of iron (as *proto-sulphate of iron*, for example), and by giving a deep bluish-black precipitate with *sesqui* or *per* salts of iron (as *persulphate of iron*) which disappears when the liquor is heated. It is distinguished from *pyrogallic acid* by its inferior solubility in water. If, in a mixed solution of gallic acid and tannic acid, a piece of depilated skin be immersed for some time, the whole of the tannin will be absorbed by the skin, leaving the unaltered gallic acid in solution.

Gallic acid is useless for tanning purposes, therefore it is of considerable importance to prevent, as far as possible, the conversion of the tannin contained in the tanning liquors into gallic acid—a change that is more likely to occur when ooze or infusion of the astringent matter is used, than when ground bark and *water* only is employed, as in the old tanning process. When tanning solutions undergo decomposition, a considerable percentage of tannin is converted into gallic acid and other modifications of tannic acid, by which a positive loss of tanning power is sustained. The tannin from galls and sumac is very liable to undergo this change, in consequence, probably, of the insoluble matters acting as a ferment, and thereby promoting the conversion of tannin into gallic acid.† This subject will be further considered when treating of *gallic fermentation*.

Although gallic acid possesses no tanning property, its

* Pure gallic acid will *not* throw down a precipitate from a solution of isinglass.

† Parnell thinks that the *malic acid* existing in sumac leaves is the cause of the rapid fermentation of sumac liquors.

existence in spent or exhausted tan liquors is sometimes taken advantage of to swell the hides after they have been limed in the usual way, instead of employing dilute sulphuric acid, by which the absorption of the tannin is promoted.

Besides being present ready formed in galls and sumac, gallic acid occurs in some other vegetables; it is said to be found in the seeds of the mango-tree, in divi divi, valonia, black and green teas and myrabolams.

Pyrogallic Acid.—When gallic acid is subjected to *dry distillation*, at a temperature between 410° and 420° Fahr., a white crystalline substance distils over, which is *pyrogallic acid*. Its preparation, according to the method suggested by Dr. Stenhouse, is as follows:—Finely powdered galls are treated with successive portions of cold water till exhausted, and the infusions carefully evaporated to dryness, when they leave a spongy, deliquescent (that is, capable of absorbing the moisture from the air) mass, which is to be pulverised and spread equally over the bottom of a cast-iron pan, 3 or 4 inches deep, and about a foot in diameter, the top of which is covered with a diaphragm of bibulous paper (filtering paper) pasted round its rim, pierced with pin holes, and surmounted by a paper cap 12 to 18 inches high. The pan is then cautiously heated for 10 or 12 hours, over an oil-bath, so as to preserve its temperature as nearly as possible at about 400° Fahr.* The crystals of sublimed pyrogallic acid collect in the cap, and the other products are chiefly absorbed and retained by the paper diaphragm.

Pyrogallic acid is white, crystalline, without odour, and of a bitter taste. When pure it does not redden litmus paper; it is very soluble in water, ether and alcohol. This acid has been much used in photography, its application having been first suggested by the author's late friend, Mr. Frederick Scott Archer—the inventor of the well-known "collodion process."

* If the heat of the bath be rapidly increased, and the oil allowed to boil, carbonic acid will be given off, instead of the crystalline sublimate, water will distil over, and a brilliant black mass left behind, which has been called, by Pelouze, *Metagallic* acid, a tasteless, insoluble substance, resembling carbon, but nevertheless a true acid.

Ellagic Acid.—This name, which is derived from the word *galle*, read backwards, was given by Braconnot to a substance formed along with gallic acid when moistened galls are exposed for some time to the air. Its existence was first noticed by Chevreul. According to Grischow, ellagic acid exists in the root of *Tormentilla erecta*. Being insoluble in boiling water, it remains after the gallic acid has been extracted, and may be dissolved out of the residue by a very weak solution of potash. If dilute hydrochloric acid be now added to this solution, a brownish precipitate is formed, which is *ellagic acid*, a tasteless substance almost insoluble in water, alcohol, and ether. It slightly reddens litmus paper. The *bloom* which appears upon the surface of tanned skins or hides, is ellagic acid.

Besides the above acids, there are numerous other derivatives of tannin, which, however interesting in themselves, are of no importance to the tanner, and therefore need not be dwelt upon in these pages.

CHAPTER VI.

GALLIC FERMENTATION.

Checking or Preventing Gallic Fermentation.

It being an established fact that tannic acid, under the influence of moisture and atmospheric air, becomes converted into *gallic acid*, it will readily be understood that tan liquors, which are constantly exposed to the air, will naturally be susceptible of this change, and, as a consequence, a portion of their active principle (tannin) must in course of time suffer decomposition. Apart from this, however, a *fermentative* process takes place in the liquors, by which a considerable proportion of the active principle is converted into gallic acid; this is denominated *gallic fermentation*, and has been a constant source of trouble and loss to the tanner. According to the researches of Larocque, the peculiar ferment of nut galls which operates the change, also converts sugar into alcohol and carbonic acid, in the same way that yeast does, whilst beer yeast, muscular flesh, and caseous matter (the solid matter of milk) change tannin into gallic acid. Hence gallic and vinous fermentation are considered to be nearly identical.

According to Wackenroder and Larocque, it appears that the formation of gallic acid from tannin is considerably expedited by the contact of the insoluble vegetable matters which remain after the extraction of the tannin, at least in the case of nut-galls, and probably in that of all vegetable matters containing tannin susceptible of this change by exposure to the air. Larocque found that all the tannin contained in an aqueous solution of that substance, to which was added the residue of the preparation

of tannin from gall nuts by means of ether, became entirely converted into gallic acid, although in a closed vessel; while a strong solution of pure tannin, freely exposed to the air during the same length of time, contained nearly the whole of the tannin unaltered. It is therefore concluded that the insoluble residue of the nut-galls contains a substance capable of acting on tannin as a ferment, and that the change of tannin into gallic acid in such cases is a species of fermentation. This is rendered still more probable, from the circumstance that the vinous fermentation may be excited in grape sugar by powdered nut-galls which have been digested in ether; and also that contact with yeast, blood and albumen, produced the same effect on tannin as contact with the residue of nut-galls, though not with the same rapidity as the latter. The gallic acid formed from the tannin of nut-galls, through the agency of yeast, is mixed with a quantity of a brown bitter substance.

Is it not probable that while tannin exists *in its natural proportion* in the tanning infusions, that it *prevents* the fermentative decomposition to which the vegetable matters would be susceptible when free from it, and that when, in the ordinary process of tanning, the skins have removed, by absorption, a considerable portion of the astringent principle, the vegetable matter then undergoes decomposition, or incipient fermentation, which, when once set in, proceeds with increasing activity? We are induced to offer this suggestion because we believe that, while tannin exists in due proportions in solution with the vegetable matters derived from the plant, gallic fermentation does not take place, but that when this proportion becomes reduced—either by the action of the oxygen of the air, or by absorption of tannin by the hides—fermentation supervenes.

Checking or Preventing Gallic Fermentation.—Labaroque has observed that the fermentative decomposition of tannin may be prevented or checked by all the antiseptic substances which arrest vinous fermentation, such as aromatic substances and volatile oils, and soluble

salts of mercury. Corrosive sublimate is said to prevent the decomposition most effectually. According to the same authority, the presence of atmospheric air is not essential to the conversion of tannin into gallic acid, and no appreciable quantity of gas is liberated during the decomposition.

It has been proved that dilute sulphuric and hydrochloric acids speedily convert tannin into gallic acid without contact of the air, when the mixture is exposed to a moderate heat; and it has been demonstrated by M. Antoine that the decomposition of tannin, when exposed to the air, is not at all accelerated, but rather retarded, by the presence of a very minute quantity of either of the above acids, provided the mixtures be kept at the ordinary temperature. Pyroligneous acid possesses the property of retarding the decomposition of tannin to a very considerable extent, probably owing in a great measure to the presence of empyreumatic bodies. On the contrary, tartaric and malic acids, and vegetable acids in general, accelerate the decomposition of tannin. The rapidity with which sumac ferments may be referred in a great degree to the presence of a considerable quantity of malic acid in the leaves, according to some analyses.—*Parnell.*

"From the preceding observations," says the same author, "may be inferred some of those conditions which the tanner should endeavour to avoid or obtain, in order to retard, as much as possible, the conversion of the tanning principle into gallic acid, the latter being incapable of combining with gelatinous tissue. Though the observations refer particularly to the tannin of gall nuts, which is believed to be the same kind as that of sumac, yet there is every reason to believe that they are applicable to all vegetable substances which contain a variety of tannin, not even excepting those the tannin of which is not convertible into gallic acid; for all kinds of tannin are subject to a fermentative decomposition, though the different varieties may afford very different products, and, in all probability, the same agents which possess the power of

restraining the fermentation of one variety would that of another. An idea prevails amongst some tanners, however, that gallic acid exerts some beneficial action or other in the process of tanning. This we certainly admit, provided the ordinary process is followed; but undoubtedly it is at the expense of a far more valuable and important agent."

As to the part which gallic acid performs in the process of tanning, since it is well known that it does not enter into the substance of the skin, so as to form a constituent of the leather, we may take it that its functions are of a secondary character, merely aiding the absorption of the tannin by swelling the pores of the skin, in the same way, and to about the same extent, as dilute sulphuric acid. If, however, the hides, after liming, have been raised by the dilute mineral acid, it is difficult to conceive that gallic acid performs *any* useful part in the operation of tanning. If it could be shown that this acid assisted in promoting the combination of vegetable extractive with the substance of the skin, its importance as a constituent of tanning infusions would be readily understood and appreciated, and indeed it may be possible that in some way not yet understood such is really the case.

Knowing that the oxygen of the atmosphere readily converts the tannin of tanning infusions into gallic acid,* may we not conclude that the process of *handling* favours this chemical change? The skins, while supersaturated with tan liquor, are repeatedly exposed to the air, and the liquor which attaches to them, as also that which flows from them, after removal from the pits, necessarily exposes a very large superficial surface to the action of the air; and it is not reasonable to suppose that under these conditions a considerable portion of the tannin is transformed into gallic acid? If this be so, is not the process of handling, as at present conducted, a mistake?

Is not the system of *suspension* preferable? Against this method it has been urged that after a while the tanning liquor, by remaining stagnant, suffers decomposition;

* Especially when other organic matters are present.

this, however, could be checked by keeping the liquor in gentle motion by means of a suitable agitator, by which the skins would be constantly exposed to fresh surfaces of the liquor, while at the same time it would be kept in an uniform condition until the whole of the tannin had become absorbed, when the spent liquor would be run off and replaced by fresh, in the usual way. The arrangements described in another place, would appear to be a feasible plan of treating skins in tan-liquor, and would, we should say, render the process of handling to a great extent unnecessary.

Carbolic acid has been frequently used, with good effect, to check gallic fermentation; pyroligneous acid (wood vinegar) has also, as we have said, been employed, but since its action is believed to be chiefly due to the empyreumatic matter with which it is impregnated, probably commercial wood spirit *(pyroxilic spirit)*, in small quantities, would have a similar, if not a more powerful, effect, since it contains a still larger quantity of empyreumatic matter. We are not aware if this substance has been tried, but are disposed to think that a few experiments might be made with advantage. Being soluble in water, in all proportions, there would be no difficulty in applying the wood spirit; the quantity used must be small, however, otherwise it will impart its natural, but not disagreeable, odour to the leather; this, however, would probably disappear during the treatment of the skins in the layers.

CHAPTER VII.

TANNING MATERIALS.

Sources of Tannin.—Barks.—Oak Bark.—Barking of Trees.—Nut Galls.—Tanning Extracts.—Catechu.—Kino.—Gambier or Terra Japonica.—Hemlock Extract.—Chestnut Extract.—Oakwood Extract.—Larch Extract.—Quebracho Extract.—Sumac.—Rhatany Root.—Mangrove Extract.—Myrobalans.—Valonia.—Divi divi.—Mimosa Bark.—List of Tanning Materials.—Miscellaneous Tanning Materials.

Sources of Tannin.—Since the period when Lewis, Deyeux, Seguin, Davy and others investigated the principles of tanning, the vegetable kingdom has been industriously explored, and a vast number of plants examined to determine the presence of tannic acid and its proportion in the various parts of trees, shrubs, and herbs. These researches have not only increased our knowledge as to the wide diffusion of the important proximate principle, tannin, but have also developed new sources from which it can be obtained with advantage for the purposes of the tanner.

The sources of tannin are classified under the following heads, namely—

Barks, as of the oak, birch, mangrove, mimosa, &c.
Roots, as of rhatany, male fern, tormentil, &c.
Leaves, as of sumac, pomegranate, tea, &c.
Excrescences, or gall nuts.
Extracts, as catechu, gambier, &c.
Flowers and Fruits.
Seed pods.

Barks.—One of the most important sources of tannin is the bark of certain trees, but more especially of the various species of oak, willow, hemlock and chestnut. The bark

is the rind or exterior covering of vegetables, corresponding to the skin of animals. It consists of the *cuticle*, or *epidermis*, the *parenchyma*, a cellular structure containing colouring matter, &c., and *liber*,* the inner or true bark. This last is formed of woody fibre in great quantity, intermixed with cellular tissue. At the commencement of the annual growth of a tree, the bark separates spontaneously from the wood, in order to make room for the new matter forming beneath. It thus increases by yearly layers, and gradually perishes on the outside, owing to the distension from the growth of the inner portion. Its *physiological uses* are numerous and important; it is the depository of many of the secretions of plants, and it acts as a living filter, separating secretions from each other, and allowing a part of them to pass off horizontally through the medullary processes on their way to the centre of the tree. But the principal offices of the true bark appear to be to act as a protection to the tender wood, and as a channel for the sap in its descent from the leaves. This latter function directs attention to that period of the year when the sap is in most vigorous circulation—the *spring*, at which time the active principles deposited in the cells of the bark are most abundant. For example, oak bark collected in spring contains *four times* as much astringent matter as that collected in winter.—*Cooley*. With few exceptions, the bark is more easily removed from a tree in spring than at any other period of the year. When a tree, or one of its branches, is cut across, the bark is easily distinguished from the interior layers by its colour; and if we examine the bark we find that its three layers are perfectly distinct, and may be readily separated.

Oak Bark.—This most important of all tanning materials has always been employed by British tanners in preference to any other; and although large quantities of tanning materials from other sources are consumed in Great Britain, their employment is rather from necessity—owing to the weakness in tannin of oak bark—than from

* So called from *liber*, a book, because in the early ages the inner bark was stripped off in layers, and formed into leaves, for writing upon.

choice. Oak bark yields its tannin under the most favourable conditions for the gradual combination of the astringent matter with the tissue of the skin, and at the same time it parts with its extractive matter in such a way that by slow degrees it enters into the substance of the skin, and doubtless plays an important part in the formation of sound and durable leather.

There are several varieties of oak, the barks of which are famous for their richness in tannin, amongst which may be named *Quercus robur*, *Q. coccifera*, *Q. suber*, European varieties; *Q. falcata*, *Q. rubra*, *Q. tinctoria*, &c., indigenous to America. "The bark of *Quercus robur*—which term is applied to designate a group of closely-allied species or varieties, and of which the *Q. pedunculata* and *Q. sessiliflora* form the two principal—is generally preferred by the tanner, with the exception of Norway, the North of Russia, and some districts in France. In Norway the birch and willow are resorted to, and in Russia and France, the bark of other species of oak, the *Quercus glomerata* and *Q. coccifera* are occasionally substituted. The latter variety, known also as the *kermes* oak, is a tortuous, branching shrub, inhabiting the south of France, Portugal and Spain. It grows to the height of three or four feet, in close clumps, the roots interlacing one another, so that the soil, which might otherwise be washed away by the heavy rains, is retained. The bark of the root of this shrub, which is sometimes called *coppice oak*, is of a yellowish-brown hue, and very rich in tannin. It is much in request in France for tanning sole leather of a superior quality."—*Muspratt.*

The common English oak (*Q. robur*, Linnæus) is by some botanists named *Q. pedunculata;* its acorns are borne on long peduncles (stems supporting the fruit), and is thus distinguished from *Q. sessiliflora*, which has its acorns clustered upon a very short stalk, or *sessile* (sitting), with leaves on elongated stalks. When deprived of its epidermis, it is of a light brown colour externally; it has a slight odour, but the taste is bitter and roughly astringent. Its properties are readily extracted by water

and by proof spirit. Its constituents are tannin (about 15 per cent.), gallic acid, uncrystallisable sugar, tannates of lime, magnesia, potash, &c. The inner part of the bark, as before observed, contains the largest proportion of tannin.

Barking of Trees.—Since observation has proved that tannin exists in the bark of trees during spring time to a much greater extent than at any other period of the year, it must be evident that great care is necessary to obtain the bark when it is in a condition most favourable to the requirements of the tanner. Until the subject had been thoroughly investigated—and in this the careful researches of Davy and other scientific men have been of immense service to the tanner—the rind of old oaks was deemed of more value for tanning purposes than the product from younger wood. Experience, and a more intimate knowledge of the chemistry of the subject, have shown that not only does the bark of younger wood yield more tannin than that from older trees, but the leather prepared with it is softer and whiter. "Doubtless the best age at which the trees should be barked is from eighteen to twenty-five or thirty years; but owing to the importance of the timber for building and other purposes, rarely are trees of this age felled in England or European countries. In France, however, they harvest the bark of the oak at this age, but the wood is not turned to further use, excepting for the manufacture of charcoal, owing to this variety not being adapted for the builder. In France, too, the advantage may be gained of collecting the bark in the spring, at a time when the sap is in full flow, and when there is most tannin contained in it; but in other countries, where the bark of the tree constitutes only an inferior secondary product, compared with the wood, this season is not chosen, in consequence of the timber being cut when the sap is in active circulation, and thus less liable to decay."—*Muspratt.*

The period for debarking the trees in England, Holland and America, is about June, but this depends upon the mildness of the winter and spring. Barking is performed

by cutting two circular bands round the trunk, about two or three feet apart; a longitudinal strip is then cut from one band to the other and the bark loosened at the upper band and stripped off by means of peeling irons, the bark being beaten when necessary. The strips, when removed, are spread out to dry, in beds, in a shady situation, and they are turned over occasionally to prevent the bark from heating.

The harvesting of the bark requires to be conducted with great care, otherwise not only will the bark suffer loss of tannin, but also produce an inferior leather in the tan pits. Muspratt observes, "For the most part, or, indeed, in all cases, the bark should rest on hurdles elevated more or less from the ground, in an inclined state, and the fragments ought never to be heaped together more than twelve to eighteen inches in thickness. Provision ought to be made to protect the bark from the rain, and the whole should be turned at least once a week till quite dry. After this it is usually stacked in rectangular heaps, and protected by thatch, if not by a roof, from rain and wet."

In the year 1897 it was stated that about 40,000 tons of oak bark was annually imported into England from Germany, the Netherlands, and ports in the Mediterranean, but there is no means of ascertaining how much English oak bark is obtained.

Davy gives the following quantities of tannin contained in oak bark:—

480 lbs. of entire bark, of a middle sized oak, cut in spring	29	lbs.
,, coppice oak	32	,,
,, oak cut in autumn	21	,,
White cortical layers	72	,,

According to Braconnot, oak bark contains, besides tannic acid, tannates of the earths, gallic acid, pectin, and lignin.

The proportions of tannin in Elm, Willow, and other barks, &c., are given in the foregoing table.

Cork-tree bark is obtained from *Quercus suber*, a species of oak growing in Spain, Tuscany, and the islands of

Corsica and Sardinia, and on the northern coasts of Africa. The outer layer or bark of the tree constitutes what is known as *cork*, while the inner layer, which is of considerable thickness, is procured, from its richness in tannin (about 12 per cent.), as a tanning material, the greater portion of which is employed by the tanners of Ireland.

Nut-galls.—These remarkable excrescences, which contain a large percentage of tannin, and also gallic acid, are imported largely into England from Smyrna, being the produce of Asia Minor; also from Aleppo, the produce of the vicinity of Mosul in Kurdistan, a province of Persia. They are also imported from Bombay. Besides the names applied from the places whence they are obtained, the Levant galls are distinguished by their physical characteristics, being called Blue or White galls. The *Blue galls* vary in size, and are of a bluish-grey colour. They are gathered before the insect (*Cynips*) becomes fully developed, or worked its way out of the nut. Some of these are larger, and are called *Green galls*, from being of a greenish colour. They exhibit on their otherwise smooth surface, a number of bluntly-pointed tubercles, which would appear to be the apices of leaves stimulated into unnatural growth. The best galls are heavy, hard, and shining, and break with a short flinty fracture. *White galls* are so called from being of a lighter colour than the others, but still of a greyish or yellowish hue. They are distinguished by being perforated with a small round hole, by which the insect had escaped. They are usually less heavy than the others, have a larger internal cavity, and are not so astringent. A third variety, called *Large Mecca galls*, are sometimes imported from Bussorah; they are called Dead Sea Apples, and *Mala insana*. They are identical with some specimens brought by the Hon. R. Curzon from the Holy Land in 1847. They are spherical in shape, and surrounded about the centre by a circle of horned protuberances. They are astringent like other galls, and, when fresh, are said to be purple and shining. They are thought to be the produce of a peculiar variety

of *Quercus infectoria*, which grows on the mountains near the Dead Sea. Peculiar galls of an irregular shape have occasionally been imported from China, where they are known by the name of *Woo-pei-tzee*. They are very astringent, and are supposed by Dr. Schenk to be formed by the puncture of the leaves of the *Rhus semialata* (*Terebinthacas*) by a peculiar species of *Aphis*.

Tanning Extracts.—Catechu.—This important tanning material is also known in commerce by the names *Cashew*, *Cutch*, *Gambier*, and *Terra Japonica* (Japan earth). Catechu is properly an extract prepared from the wood of *Acacia Catechu*, but the term is now applied to other *extracts* similar in appearance and properties. The *leaves* of the *Uncaria gambir* yield an extract which is known in commerce as *Terra Japonica*, *Gambir*, or *Gambier*, which is prepared in square pieces or blocks (cube gambier). The acacias, however, are most famous for the secretion of astringent matter in the wood, bark, and legumes (seed vessels) of various species, from which the catechus of commerce are obtained. Catechu is generally in square or roundish pieces or balls, varying in colour from a pale whitish or light reddish brown, to a dark brown colour; it is either earthy in texture, lamellated, or presents a smooth shining fracture. Some kinds are more friable (easily crumbled) than others, and all are without smell. The taste is powerfully bitter and astringent, and leaves a sweet after-taste. The pieces are generally of a darker colour externally than they are inside. Some kinds are covered with rice husks, others are enveloped in leaves. The *pale* variety is usually distinguished from the *dark* coloured, and is said to be imported from Calcutta, but we have obtained both kinds in the bazaars there, the pale being imported from the upper provinces, and the dark from Pegu and Singapore. The dark brown catechus are obtained from Bombay, but both kinds may no doubt be prepared from the same tree, as a greater degree of heat, or longer continued heat, and greater exposure to light, is said to produce the dark colour. The dark are heavier, more dense in texture, and have a resinous fracture. The

largest portion of good catechu is taken up by water, especially when boiling, the infusion being of a light red or reddish-brown colour, according to strength : it reddens litmus, and is strongly astringent in taste. It yields a precipitate with the salts of ammonia, also with acetate of lead, and one of a blackish-green colour with the salts of the sesquioxide of iron.—*Dr. Royle.*

Sir Humphry Davy, in analysing the dark and pale catechu, or those of Bombay and Bengal, obtained from—

	Of Tannin.	Extractive.	Mucilage.	Insoluble Residuum.	
Dark catechu ..	109 ..	68 ..	13 ..	10	= 200
Pale „ ..	97 ..	73 ..	16 ..	14	= 200

The principle which Davy termed *extractive* has since been named *Catechine*, or *Catechuic acid.* This is most easily obtained by treating gambier with cold water ; the tannin being dissolved, the insoluble residue is impure catechine, which may be purified by dissolving in alcohol and subsequent crystallisation, when it has the appearance of a white powder, but is in the form of silky needles, of a somewhat sweetish taste, producing a green colour with salts of iron. M. Soubeiran, who made a series of experiments with catechu, came to the conclusion that Pegu catechu is the most astringent of all the vegetable astringents ; next to this, in astringency, is Jamaica kino ; next Amboyna kino ; fourth on the list is Indian catechu, and fifth, extract of rhatany. 8 parts of Pegu catechu are found to contain as much tannin as 10, 12, 14, and 15 parts of the others respectively.

The characteristics of the principal varieties of catechu are as follows :—

Bombay Catechu.—Firm, brittle, dark brown, of a uniform texture, and a glossy, semi-resinous and uneven fracture. Specific gravity, 1·39. Richness in tannin, 52 per cent.

Bengal Catechu.—Rusty brown colour externally ; porous, and more friable than the preceding. Sp. gr. 1·28. Richness in tannin, 49·5 per cent.

Malabar Catechu.—Resembles the last in appearance,

but is more brittle and gritty. Sp. gr. 1·40. Richness in tannin, 45·5.—*A. J. Cooley.*

Kino, or Gum Kino.—This well-known astringent substance is described in the *British Pharmacopœia* as "the juice flowing from the incised bark of the *Pterocarpus marsupium*, or Indian kino-tree, hardened in the sun; it is also the concrete juice of *Pterocarpus erinaceus* (in Africa), and of other undetermined genera and species." From the uniformity of its appearance, it would appear to be the natural gummy exudation of some one plant, but several kinds of kino are met with in commerce which are known to be the products of various plants, as that of *Butea frondosa*, from India, Botany Bay kino, produced by *Eucalyptus resinifera*, or brown gum tree, also a Jamaica and a Columbian kino, and sometimes an extract of rhatany has been included in the list. The genuine kino has been supposed to come from the west coast of Africa, but it is understood that the best is now imported from Bombay.

Kino is in small, irregular, somewhat angular, glistening fragments, of a dark brown or reddish-brown colour, brittle, and affording a powder which is lighter coloured than the masses. It is without odour, and has a bitterish, highly astringent, and ultimately sweetish taste. It is not softened by heat; cold water dissolves it partially, boiling water more largely, and the saturated decoction becomes turbid on cooling, and deposits a reddish sediment. Alcohol dissolves the greater portion. It consists chiefly of a peculiar modification of tannin and extractive matter, and in some of the varieties, of a minute portion of resin.—*Royle.* According to Vauquelin, it contains no gallic acid, but tannin and peculiar extractive, 75; red gum, 24; insoluble matter, 1. Its aqueous solution is precipitated by gelatine (with which it produces a gum, in consequence of the presence of a little catechine), by salts of iron, &c. The alkalis favour its solubility in water, but essentially change its nature, and destroy its astringent property. Soubeiran states that kino contains more tannin than Indian catechu, but less than

Pegu catechu, and also that infusions of kino and Indian catechu alike produce a brown colour with solutions of perchloride of iron, with which Pegu catechu forms a green.

Gambier, Gambir, or Terra Japonica (Japan earth) is an extract from the plant *Uncaria gambir*—a native of Malacca and the neighbouring islands, and was imported from Singapore in 1904 to the extent of about 160,280 cwts. It occurs in the market in the form of bales weighing about 2 cwt. each, but a superior article, called *cube gambier*, comes to us in the form of small blocks. For a long period the English tanners failed to understand the proper mode of employing this agent, for when employed alone, besides imparting a dark red colour to the leather, it produced a soft and spongy article. It is now better understood, however, and is much employed, in moderate proportions, in the preliminary stages of tanning.

Hemlock Extract.—The great success of hemlock tanning in the Northern States of America, has led to the importation into this country of large quantities of an extract of this important tanning material, which is extensively used, in combination with other tanning agents.

Chestnut Extract.—This is another comparatively recent tanning material, chiefly imported from France, being obtained from the wood and bark of the tree.

Oakwood Extract is now also very largely used as a tanning agent, as also,

Larch Extract, or Hungarian Larch Extract, which is favoured to some extent by English tanners of light leathers.

Quebracho Extract, from the bark of *Aspidospermum quebracho,* is also now largely used in Britain, Germany, and America.

Sumach, or Sumac.—This much esteemed tanning material—especially for light coloured leathers—is a powder of the leaves, peduncles, and young branches of *Rhus coriaria* and *R. cotinus* (wild olive), the product of the former being employed by the tanner, more especially in the preparation of morocco and similar leathers,

while that from the latter is used in dyeing. *Rhus coriaria* is a shrub growing wild in Portugal, Spain, Italy, Sicily and France, which countries produce considerable quantities of sumac, varying in quality, and distinguished from each other by the habits of the plant, the colour, and other properties. The shrub grows to the height of from four to eight feet, with a crooked stem, covered with a reddish-grey bark ; its leaves are green on the upper surface and of a whitish colour on the under surface during spring and summer, but they acquire a reddish hue in autumn. The plant flowers in July, the blossoms being of a greenish-red, and it yields clusters of small crimson berries.

Sumac, as a tanning material, is chiefly preferred, especially on the Continent, for its not imparting colouring matter to the leather prepared with it. It is stated that one drawback in its employment is that it deprives the skin of much of its softness and pliability. In the manufacture of morocco and glazed leather it is largely used ; and when mixed with bark or other tanning material it yields very good results.

Muspratt says:—"Of the species of sumac in the market, the Sicilian is accounted the best. There are two kinds, one of which, the Alcamo, is the most esteemed. It is a very fine light green powder, containing very little woody matter, having an agreeable odour, analogous to that of the violet, and a strong astringent taste ; it contains very little colouring matter, though it gives a yellowish-green solution when macerated with water. The second variety inclines to a reddish yellow, has a feeble odour, with a less astringent taste than the foregoing variety. On this account it is not much employed in tanning, though extensively used in dyeing. Sicilian sumac is generally packed in bales weighing about one and a half hundredweight. Spanish sumac is various in quality, being less carefully prepared, and consequently more or less mixed with woody matter. The best sort comes from Priego, and is grown in the neighbourhood of Malaga. It is, like the Sicilian, finely ground, and

affords a colour of equal or greater brightness; its odour reminds one of the tea plant. With water it gives a dark and more reddish solution than the foregoing. It is usually packed in bales of one cwt. The other sorts, Molina and Valladolid sumac, are next in quality; they are very similar. Portuguese, or Porto, sumac is almost similar to the Priego, but is generally dirtier, and contains more mineral salts. Italian sumac has a dark brown colour, is free from woody matter, but feels granular in the hand, and has an odour like that of the bark, which possesses similar qualities to the leaves. French sumac is similar to the preceding. Three sorts are collected. The *Fauvis* is almost equal to the Sicilian when well purified, and comes from Brignolles, near Marseilles. If less care be taken in its manufacture it approaches more to the quality of Malaga sumac; it frequently goes under both these names. A second sort, *Donzeri*, and a third, *Pudis*, are commonly used in the tanneries. A fourth variety, called *rodou* or *rédoul*, obtained from the *Coriaria myrtifolia*, cultivated in Languedoc, is of a greyish-green colour.

The method of preparing sumac for the market consists in collecting the twigs of the shrub whilst in full foliage and drying them in the sun. The leaves are afterwards separated by threshing, and are then collected and ground under mill-stones; the powder is then packed in bales for the market. Sometimes the peduncles and more tender shoots are ground with the leaves, but since these portions of the shrub contain a good deal of tanning principle they do not much detract from the quality of the material.

Rhatany Root.—The rhatany plant (*Krameria triandria*) is a native of Peru, where it grows on the slopes of the sandy mountains, more particularly near Huanuco, where it was discovered by Ruiz, who found that the root was employed by ladies for rubbing the teeth and strengthening the gums. The root is woody and branched; the pieces vary from an inch to the size of a quill. The cortical part is reddish-brown, fibrous, and

easily separated from the central reddish-yellow woody part. The root is without smell, but has an extremely astringent taste without being bitter. The cortical portion contains a much larger percentage of the active principle than the interior; the smaller pieces from the greater proportion of the bark are the most rich in tannin. An extract is sometimes imported from South America.

Rhatany root consists of one-third matters soluble in water; these consist of tannin, 42·6; gallic acid, 0·3; gum, extractive and colouring matter, 56·6; and krameric acid, 0·5. Water and alcohol both dissolve its active properties, forming a reddish solution. According to Gmelin and Peschier, rhatany root yields:

	Gmelin.	Peschier.
Tannin	38·3	42·6
Gallic acid	—	0·3
Sweet matter	6·7	—
Nitrogenous matter	2·5	—
Mucilage	8·3	—
Lignin	43·3	—
Krameric acid	—	0·4
Gum, extractive, and colouring matter	—	56·7
	99·1	100·0

Mangrove Extract.—Of late years much attention has been devoted to mangrove bark and its extract. The mangrove species is found growing in swamps in most tropical parts of the world, the tannin-yielding trees being known as *Rhizophora mangle*, and other allied species. The trees grow in the tidal districts of East India and Borneo freely, and of late years several extracting plants have been installed in the latter country, and the tannin extract exported in the form of a dry crystallive product known under various fancy names. The percentage of tannin contained in the bark varies considerably, some going as high as 45, whilst others yield only 5 per cent. The catechol tannin is easily extracted, but is of a deep reddish tint, which, when used alone, makes an objectionable coloured leather. The extract contains from 60 to 70 per cent. of tannin, and much of the colour is eliminated in the course of manufacture.

It is one of the cheapest forms of tannin now on the market, and bids fair to become very popular.

Myrobalans (also called Myrabolams).—The myrobalan is the fruit of several species of *Terminalia*, namely *Terminalia chebula, T. bellerica, T. citrina*, and *Emblica officinalis;* these trees abound in Hindostan, Ceylon, Burmah, &c. The myrobalan varies in size from that of a small hazel nut to that of the nutmeg. The tannin occurs in the pulp which surrounds the kernel. When employed alone in tanning, myrobalans deposit a considerable quantity of *bloom* or ellagic acid; they are, however, generally used in combination with other tanning materials, from their usefulness in modifying the objectionable colour which some of the latter impart to leather prepared with them. Owing to the extreme hardness of the nut, or stone, it requires to be ground by a mill specially constructed for the purpose.

Valonia.—This name is given to the calyx, or cup, of a large acorn, the fruit of a species of oak, *Quercus ægilops*, which abounds in Asia Minor, Roumelia, and Greece. Some botanists have recognised other varieties of Valonia oak, as *Quercus macrolepis* and *Q. stenophylla*, growing in the Greek peninsula. The largest supply of valonia, however, comes from Smyrna. It has been stated that Palestine abounds with the valonia oak, and the late Mr. Sparke Evans thought that it might be successfully grown in Australia, and thus become a source of wealth to that colony, which, possessing neither large rivers nor extensive forests, has more need to cultivate shrubs of commercial value. The suggestion is a good one, and deserves to be further promulgated.

In an interesting paper in the *Tanners' Journal* respecting valonia, the writer gives some very useful information, from his own personal observation, from which we extract the following: "The fruit begins to ripen in July, and is ready for the cultivator in August. Some small portion of it never attains maturity, and either falls off the trees of itself, or is beaten off in the shape of *camata* or *camatina*. These two trade terms signify those cups

that have not opened fully, and remain with the acorn stunted, and so embedded in them that it cannot be extracted. . . . . The acorns which grow in the cups are gathered with them, but the knocking about which the fruit is subjected to before it is finally despatched to Smyrna, and the mere fact of drying, suffice to detach a great number in the meanwhile, and the produce thus reaches our market with only a small portion of them. The valonia is put into sacks, and is then forwarded by camels to the nearest railway station. . . . . The valonia, having reached Smyrna, is emptied into dry, commodious, and well-aired stores specially built here for the article, and then undergoes the process of picking and cleaning. This is done principally by women, children, and infirm old men incapable of hard work. The smaller, or 'spine,' is separated from the cups, which are placed apart. The former is always mixed with a proportion of earth and stones collected with the fruit from the ground, and has to be freed from this extraneous substance. The cups are placed in large heaps before the cleaners, who rapidly lay aside all the damaged cups and all the acorns, and push the remainder behind them with their hands after thus cleaning it. At the same time the Trieste cups are quickly thrown into separate baskets, and the valonia thus leaves the workers' hands in three distinct qualities—Mezzana, English, and refuse. The first, however, which consists of the finest large cups, is not picked out of all parcels. In many cases it is allowed to remain in the English quality, which then takes the name of 'natural,' from the fact of its thus containing all the sound cups originally produced." From this it will be seen that valonia of the second quality only is exported for England.

Divi divi is the pod of a leguminous shrub (*Cæsalpinia coriaria*), a native of South America and some other tropical countries; it is also cultivated in Madras, Hindostan, Ceylon, and other parts of India. The tannin of the seed-pod exists in the tissue beneath the epidermis, the seeds themselves yielding no tannin. The tannin is

generally extracted by boiling the material in separate pits, while others crush the pods in a mill, and employ them as dust for the handlers. The employment of divi divi in the tannery, however, appears as yet to be but imperfectly understood. Containing, sometimes, nearly 50 per cent. of tannic acid, it should be a valuable tanning agent; but since it also possesses a considerable proportion of mucilaginous and oily matter, it is very susceptible of fermentation, especially, it is stated, in warm weather, or when the atmosphere is subjected to electrical disturbance. The late Mr. Sparke Evans said: "This causes, at times, much annoyance and some loss, as one of our Bristol tanners found to his cost, when one day, passing through his drying shed, he came to a pile of divi-tanned butts, which had been laid down to temper, but through which he was able to thrust his walking stick as through a honeycomb. Divi-tanned leather feels firm in dry, but soft in damp weather. A fortune is open to any one who can employ this article in tanning and prevent the dark colour which accompanies its use." To check the fermentation to which divi divi is specially liable, acetic acid, and more recently carbolic acid and salicylic acid have been used; a preparation called *Antigalline* has also been used with some degree of success.

Mimosa Bark.—This material is obtained from various species of *Acacia*—an extensive family, of which the well-known *Sensitive plant* is a remarkable member. The species from which the mimosa of commerce is derived are:—*Acacia molissima, A. decurrens, A. pycantha, A. dealbata,* and some others. The acacias abound in Australia and Tasmania, and large quantities of the bark are exported to this country—by far the greatest quantity, however, coming from the former colony. Mimosa is generally chopped or ground previous to exportation, and it has also been introduced in the form of an extract. The bark contains varying proportions of tannic acid, the mean being about 24 or 25 per cent. Being exceedingly hard, the bark requires to be very finely ground to extract all its tannin. It makes a red leather, and

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is frequently used with valonia to correct the colour produced by the latter.

List of Tanning Materials.

Common Name.	Botanical Name.	Part of Plant used.	Where from.
Adurla	*Phylanthus emblica* ..	Seed pod	Bengal.
Aleppo Pine ..	*Pinus excelepensis*	Bark	Spain.
Alder	*Alnus glutinosa*.....	Bark	Gt. Britain and Spain.
Algarobiall ..	*Prosopis pallida*.....	Seed pod	South America.
Almardelboom	*Beabejum stellatum* ...	Bark	Africa.
Aru mata	.....	Bark	Australia and Tasmania.
Arok kenema	.....	Bark	Australia and Tasmania.
Arrasa	*Bucida buceras*	Bark	British Guiana and West Indies.
Asacum	.....	Extract ..	Bengal.
Babool	*Acacia arabica*	Bark	Hindostan.
Balsamo	*Carpon brevifolium* ..	Seed pod	South America.
Baramalli, or pump wood	.....	Bark	West Indies.
Bearberry	*Arctostaphilos uva ursi*	Leaves ..	Russia.
Betel	*Areca catechu*	Nut	East Indies.
Birch	*Betula alba*	Bark	Russia.
Black wattle..	*Acacia mollissima*	Bark	Australia and Tasmania.
Black wood ..	*Acacia melanoxylon* ..	Bark	Australia and Tasmania.
Blood wood ..	.....	Bark	West Indies.
Blue gum	*Eucalyptus globulus* ..	Bark	Australia
Boomah	*Pyenocama macrophylla*	Nut.....	Africa.
Butea-kino ..	*Butea frondosa*	Extract ..	Bengal.
Cascara	.....	Bark	South America.
Catechu	*Acacia catechu*	Extract ..	Bengal.
Celery Pine ..	*Phyllocladus asplenifolia*	Bark	Australia and Tasmania
Cherry tree ..	*Exocarpus cupressiformus*	Bark	Australia and Tasmania.
Chestnut	*Castanea vesca*	Bark and Extract	N. America and Spain.
Cevil	.....	Bark	South America.
Couruda.....	*Avicennia nitida*	Bark	British Guiana and West Indies.
Cork tree	*Quercus suber*.....	Bark	Spain, Italy.
Crab wood....	*Carapa guianensis*....	Bark	West Indies.
Curmpuay	.....	Bark	South America
Cutch	*Acacia catechu*	Extract ..	Bengal.
Cuyama	.....	Bark	West Indies.
Dentelaria....	*Plumbago europæa* ...	Brk.ofroot	France.
Divi divi	*Cæsalpinia coriaria* ..	Seed pod	South America.
Doomboom ..	*Acacia horrida*	Bark	South Africa.

Common Name.	Botanical Name.	Part of Plant used.	Where from.
Galls	*Quercus infectoria*	Gall nuts	Turkey.
Gambier (Terra Japonica)	*Uncaria gambir*	Extract ..	East Indies.
Gaub	*Diospyros glutinosa* ..	Root	Hindostan.
Hemlock	*Abies canadensis*	Bark	North America.
Hemlock	*Geranium maculatum*	Root and Extract	North America.
Hinan	*Elæocarpus dentatus* ..	Bark and Extract	New Zealand.
Hog plum	*Spondias lutea*	Bark	British Guiana and West Indies.
Holm tree, or Green Oak	*Quercus ilex*	Bark	Italy.
Honeysuckle..	*Banksia australis*	Bark	Australia and Tasmania.
Huldi.....	.....	Bark	East Indies.
Iron bark	*Eucalyptus resinifera*	Extract ..	Australia and Tasmania.
Kararalli	*Lecythis ollaria*	Bark	British Guiana and West Indies.
Kassu.....	.....	Extract ..	
Kermes Oak ..	*Quercus coccifera*	Bark	France.
Kino	*Pterocarpus marsupium*	Extract ..	Africa.
Knoppern	*Quercus pubescens*	Galls	Italy and Hungary.
Krupelboom ..	*Leucospermum conecarpum*	Bark	Africa.
Kullaballi	.....	Bark	
Larch.....	*Larix americana*	Bark	Russia, N. America.
Larch.....	*Larix europœa*	Bark	Great Britain.
Mangrove	.....	Extract ..	Borneo, East Indies.
Marsh Rosemary	*Statice coriaria*	Root	Russia.
Mimosa	*Acacia molissima* .... *Acacia decurrens*	Extract ..	Queensland, Victoria, and Tasmania.
Mochrus	*Bombax malebarica* ..	Extract ..	Bengal.
Molle	.....	Leaves ..	South America.
Mora	*Mora excelsa*.....	Bark	British Guiana and West India.
Murici	*Brysonima*	Bark	South America.
Myrobalans ..	*Terminalia citrina* ..	.....	Hindostan.
Myrobalans ..	*Terminalia cherbula* ..	Fruit ...	Hindostan.
Myrtle	*Fagus Cunninghami* ..	Bark	Australia and Tasmania.
Myrtle	*Rhus myrtifolia*	Bark	Italy.
Neb neb.....	*Acacia nilotica*	Seed pod	Africa, Nubia.
Oak	*Quercus pedunculata* ..	Bark	Great Britain.
Oak	*Quercus sessiliflora* ...	Bark	Great Britain.
Olive	*Olea europœa*	Bark	Italy.
Palachy.....	*Butea superba*	Extract ..	East Indies.
Pomegranate	*Punica granatum*	Fruit shell	Hindostan.
Purimbas	*Fusarmis compressus* ..	Bark	Africa.

Common Name.	Botanical Name.	Part of Plant used.	Where from.
Quebracho....	*Aspidospermum quebracho*	Bark	South America.
Quercitron ..	*Quercus tinctoria*	Bark	North America.
Red birch	*Coriaria ruscifolia* ...	Bark	New Zealand.
Red birch	*Eugenia maire*	Bark	New Zealand.
Red birch	*Fagus Menziesii*.....	Bark	New Zealand.
Rhatany	*Krameria triandria* ..	Root	South America.
Saffron	*Crocoxylon excelsum* ..	Bark	Africa.
Sassafras	*Atherosperma moschata*	Bark	Australia and Tasmania.
Saul tree	*Shorea robusta*	Bark	East Indies.
Seaside grape	*Coccoloba uvifera*.....	Bark	British Guiana and West Indies.
She oak.....	*Casuarina quadrivalvis*	Bark	Australia and Tasmania.
Silver wattle..	*Acacia dealbata*.....	Bark	Australia and Tasmania.
Sirnabelli	*Nectandra*	Bark	British Guiana and West Indies.
Sogah.....	.....	Bark	East Indies.
Squills	*Scilla maritima*	Bulb	Africa.
Statice,orMrsh. rosemary	*Statice coriaria*	Root	Russia, North America
Stone pine....	*Pinus pinea*	Bark	Spain.
Subaujuna....	*Moringa pterygosperma*	Bark	Hindostan.
Sumac	*Rhus coriaria*.....	Leaves and twigs	France, Italy.
Tamarisk galls	*Tamarix indica*	Galls	East Indies.
Tangede	.....	Bark	New Zealand.
Tarsekeha....	*Phyllocladus trichomanoides*	Bark	North America.
Tasman. laurel	*Anopterus glandulosa*	Bark	Australia and Tasmania.
Terce.....	*Cæsalpinia*	Seed pod	East Indies.
Terra Japonica	*Uncaria gambir*	Extract ..	Bengal.
Tormentil....	*Tormentilla potentilla*	Root	Spain.
Towhai	*Weinmannia racemosa*	Bark	New Zealand.
Tuga veca....	*Stryphnodendron barbatemas*	Bark	South America.
Turwar	*Cassia auriculata*	Bark	Hindostan.
Valonia	*Quercus ægilops*.....	Acorn cup	Turkey.
Wagen boom.	*Protea grandiflora*....	Bark	Africa.
Water plaintain	*Polygonum amphibium*	Root	North America.
White mangrove	*Avicennica tormentosa*	Bark	South America.
Willow	*Salix alba*	Bark	France.
Willow	*Salix cinerea*	Bark	France.

Miscellaneous Tanning Materials.—The shell of the seed of *Sapindus emarginatus*, an East Indian plant, is said

to contain 31 per cent. of tannin. Samples of the African gall nut of *Tamaria* are said to contain 56½ per cent. of tannin. The bark of *Tamaria gallica* gave, on analysis, 3·52 per cent. of tannin, and the bark of *Terminalia formentosa*, of the same family as that from which myrobalans are obtained, is reputed to yield 26 per cent. of tannin. The bark of the common alder (*Alnus glutinosa*) is said to yield about 16 per cent. of tannin. The *Eucalyptus leucoxylon*, or iron-bark of Victoria, yields about 22 per cent. of kinotannic acid ; *Eugenia Smithii*, or Australian myrtle-tree, is said to contain 17 per cent. of tannic acid. with from 3 to 4 per cent. of gallic acid. The shells of the pomegranate fruit yield about 13 per cent. of tannic acid.

CHAPTER VIII.

ESTIMATION OF TANNIN.

Examination of Bark.—Determination by Specific Gravity.—The Barkometer.—Chemical Methods of Estimating Tannin.—Davy's Method.—Bell Stephens' Method.—Hammer's Method.—Löwenthal's Method.—Mr. Hewitt on Löwenthal's Method.—Mr. Procter on Löwenthal's Method.—Ramspacker's Method. The Tannometer.—Casali's Process.—Standard Method.—International Association of Leather Trades' Chemists.

When we consider the vast number of tan-yielding vegetables which have been brought to the tanner's notice since the days when Davy first investigated the subject, the variable characteristics of the different tannins, as shown by Gmelin, Stenhouse, Procter, and others, and the difference in the percentage of tannin in the various plants, or parts of plants, which enter the market for his use, it will at once become evident that the tanner should be in possession of some means by which he may estimate the true value of all tanning materials with which he may have to deal. Moreover, when it is borne in mind that the proper *condition* of the tanning material may be seriously affected by damp or long exposure to the air, by which its active principle becomes converted into a product useless to the tanner, it is of the highest importance that the true percentage of the active principle (tannin) should be determined from a fair or *average* sample, before the bulk of the material—no matter from what source—is purchased and paid for.

With a view to aid those who may desire to test the value of their tanning materials, we purpose giving—as free as possible from unexplained technicalities—some of the methods adopted, commencing with those of the most simple cha-

racter. Before doing so, however, it may be well to consider what are the proper physical characteristics of the leading tanning material—oak-bark.

Examination of Bark.—The bark is usually in long strips, of a coarse fibrous texture, and not easily reduced to powder. When deprived of its epidermis, it is of a light brown colour externally. The odour is faint, but the taste bitter and very astringent.—*Royle.* A good bark is known by its colour. The most highly esteemed is that which is white outside and reddish inside, rough and dry on the side of the wood, breaks easily, and gives less ligneous (woody) matter; the taste most astringent with a strong smell when ground. A sign of bad quality is when the epidermis and cortex (bark) are very thick and have a blackish colour; in this case the bark is too old, and has experienced the commencement of decay. It is the same with bark which has been left a long time exposed to rain. The inner side, which should be reddish, has lost its colour, and the other parts, which have become darkened, have lost a part of their property. —*Dussauce.*

Determination by Specific Gravity.—It is well known that in all arts in which solutions of chemical substances of various degrees of strength are employed, the *approximate* strength of the solutions is determined by means of an instrument called a *hydrometer.* This instrument consists of a long glass tube with a small bulb partly filled with mercury or small shot at its lower end, and a somewhat larger bulb at a short distance above the mercury bulb. A graduated paper scale is enclosed in the longer stem of the tube, which is divided into tenths. When the hydrometer is floated in *distilled water,* it sinks to the top of the scale, which is marked 1,000 or 0 (zero)—*the specific gravity of water.* This is taken as the standard by which the specific gravity of all other fluids is determined. Since alcohol and ether, however, are lighter than water, it is evident that such an instrument would not be of service in determining their strength or specific gravity; therefore, hydrometers for ascertaining the specific gravity

of liquids *lighter* than water are constructed for the use of distillers, manufacturing chemists, and others.

The Barkometer.—To enable the tanner to ascertain the *tanning strength* of his liquors, an instrument has been devised, called a *barcometer* or *barkometer*, and is due to the ingenuity of Mr. W. Pike, of New York. It is thus described by Morfit:—

"It is made wholly of glass* (see Fig. 3), *a d* being the stem, enclosing a graduated paper scale; *B* is a spherical bulb, and *C* a smaller bulb at its base, containing quicksilver or shot, which serves as ballast to retain the instrument in a vertical position in the liquid. The scale on the stem is equally divided into five or ten wide spaces, and each of these again subdivided into ten narrow spaces. The zero point of the scale is made by plunging the instrument into distilled water at 58° Fahr., and adding mercury to the bulb until it sinks to nearly the top of the stem at *a*. A solution of ten parts of bark in ninety parts of distilled water having been made, the hydrometer is then plunged into the liquor, and the point to which it sinks therein, say *b*, is carefully and accurately marked upon the scale and rated at ten as compared with the zero point. Each of the grand divisions consequently represents ten per cent. of bark, and each of the smaller ones or subdivisions corresponds with one per cent. of the bark. It is very easy, therefore, after having determined the length of the stem from zero which sinks in a normal solution of bark, to apportion the rest of it with the aid of a pair of dividers, so that every interval thus apportioned shall be equal to that fixed by experiment.

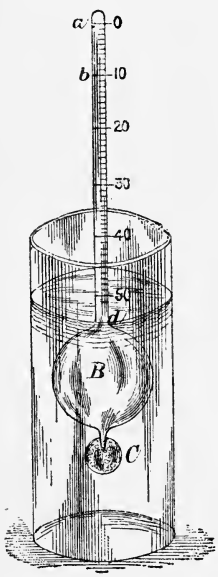

Fig. 3.

* Brass barkometers are now often used in the tanyard.—Ed. *Fifth Edition.*

"When, therefore, this instrument sinks into a bark liquor to 20°, 30°, or any other degree, the number indicates the percentage of tanning power. [A convenient form of hydrometer glass is shown in Fig. 4.] It is necessary to observe that this instrument is applicable only to *freshly* made liquors, for otherwise confusion and want of confidence might ensue upon finding that it sinks, sometimes to a corresponding degree, in spent liquor. This is owing to the fact that the alterations which tanning liquors undergo during use and exposure may not diminish their density, though they impair or destroy their tanning power." Indeed, the accumulation of gallic acid, vegetable extractive, and other constituents of bark in much-used liquors, would render the barkometer practically useless as an indicator of the presence of tannic acid. It should therefore only be employed in testing the strength of *fresh liquors*, and even then the liquors should always be tested at the mean temperature of 60° Fahr., since the gravity of the liquors is greatly influenced by their temperature.

Fig. 4.

Chemical Methods of Estimating Tannin.—The earlier methods of determining the percentage of tannin in vegetable substances were based upon the well-known affinity of this substance for gelatine; but it was soon discovered that when solutions of tannin and gelatine were mixed together, the first precipitate of tanno-gelatine contained a larger percentage of tannin than the last, and consequently the gelatine test was open to objection where absolute accuracy was required. This method of forming

an *approximate* estimate of the percentage of tannin, however, is useful in cases where the higher chemical tests would not be so readily understood.

Davy's Method.—One ounce of dry bark is reduced to a fine powder and digested in a pint of boiling water, with frequent stirring. After twenty-four hours' repose, the clear liquor is filtered through a cloth. Now dissolve one drachm of the *best* isinglass in one pint of warm water with stirring; add the isinglass to the water gradually, to prevent it from agglutinising. Take equal quantities of these two liquors and mix them together; a flaky precipitate is at once formed. The mixture must now be filtered and the precipitate collected, dried, and weighed. The difference of weight indicates the proportion of tannin. The precipitate (tanno-gelatine) generally contains forty per cent. of tannin.

In examining this method of estimating tannin, Mr. Bortwick found that much of the precipitated gelatine remained in the filtered liquor, and could not be separated by the filter, and also that the first portions of the precipitate contained 50 per cent. of tannin, while the latter portions contained very little. There is no doubt, however, that Davy's estimate was based upon the fact that the precipitate was a compound of gelatine and tannin, and if the weight of the first was known, the difference in weight, after careful drying, must of necessity be the weight of tannin absorbed.

Davy also suggested the following method: A piece of skin is dried and weighed; it is then immersed in the liquor containing tannin for some hours, after which it is dried and weighed again. The increase in weight gives the quantity of tannic acid.

Bell Stephens' Method.—This plan, originally suggested by Davy, is based upon the power of skin to absorb tannin. A piece of skin, dried over a hot-water bath, is carefully weighed. It is then soaked in water at about 90° Fahr., until perfectly soft, and is next immersed in a weak solution of the tannin to be examined, which should be heated to about 90° Fahr. In about seven or eight

hours the skin will have absorbed all the tannin, when it is again dried and weighed. The increase in weight acquired by the skin indicates the quantity of tannin it has absorbed. One advantage of this process is that the appearance of the skin, after being thus partially tanned, shows what *colour* the tanning material would impart to leather prepared by its agency.

Another method of estimating the strength of tannins, upon the above principle, is to take a given weight of dried shavings of unhaired skin, to immerse them in warm water until thoroughly softened, and then to place them in a weak and warm infusion of the tanning material to be examined. After a few hours' immersion the fragments of skin are withdrawn and carefully dried over a water-bath; when perfectly dry they are again weighed, when the difference in weight will show the amount of tannin which has been absorbed. Of course it is absolutely necessary, in adopting these methods of ascertaining the percentage of tannin, to leave the skin sufficiently long in the liquor to absorb *all* the tannin; and in order that this should be determined with certainty, a few drops of a solution of gelatine may be added to the liquor after the skin has been removed, when, if no *turbidity* is produced by the gelatine, it may be concluded that the skin has taken up all the tannin. Again, it is of paramount importance that the skin, or fragments of skin, should be *absolutely* dry at the time of weighing, otherwise all calculations will be misleading.

Hammer's Method.—The *specific gravity* of the tannin solution to be tested is first ascertained by means of the *hydrometer* before referred to. This will show the *density* of the solution as compared with water (1000). The tannin is next removed from the solution by immersing skin in it until all the tannin has become absorbed. The hydrometer is now again placed in the liquor, when the decrease in its density or specific gravity will be proportionate to the quantity of tannin in the original solution.

Besides the above methods of estimating tannin, which

may be considered to give fairly approximate rather than actual results, there have been many processes of a more purely chemical character introduced from time to time, from which we will select the one which has found most general acceptance as a reliable method in the hands of persons accustomed to laboratory manipulation. We refer to the process of Löwenthal, which has been the subject of much consideration, and also to some modifications by which it has been rendered somewhat more easy of manipulation.

Löwenthal's Method.—This method of estimating the percentage of tannin is generally accepted as reliable, though of a somewhat complicated character. It is based upon the oxidising power of permanganate of potash; and this system of analysis *by oxidation* is termed *titration*. The material to be examined being mixed with an oxidisable substance, as indigo, for example, is *titrated* with the oxidising agent, which in Löwenthal's process is permanganate of potash. The process is thus described: * —"The instruments required, besides a good balance and a few glass beakers and funnels, are merely a flask gauged at the neck to hold a *litre*,† a few pipettes and graduated glasses, and a Mohr's *burette* with a glass tap. The latter is simply an upright tube with a tap at the bottom, graduated down the side like a measuring-glass, and the most suitable size for the purpose is one delivering twenty-five cubic centimetres, and divided into two hundred and fifty parts.

"The following solutions must be prepared: I. Four grammes of pure permanganate of potash in three *litres* of distilled water. II. Five grammes of *pure* 'precipitated indigo' in one litre of water. III. Dilute sulphuric acid —one part acid to three parts water. IV. Twenty-five grammes of good transparent glue, well swollen in cold water, and then dissolved by gentle heat, the solution being made up to one litre with water and saturated with pure table-salt. V. A saturated solution of pure salt con-

* *Tanners and Curriers' Journal*, March, 1877.
† See French Tables of Weights and Measures.

taining twenty-five cubic centimetres of sulphuric, or fifty cubic centimetres of hydrochloric acid per litre.

"Although this seems rather a formidable list, it is not a costly one, and all the solutions may be kept for a long time in stoppered 'Winchester' bottles. To make an analysis, 10 grammes of sumach or 20·25 grammes of bark are exhausted by boiling with water, and the solution, when cold, made up to one litre. Of this infusion, 10 cubic centimetres are mixed with, say three-quarters of a litre of water, 25 cubic centimetres of the indigo solution, and 10 cubic centimetres of the dilute sulphuric acid are added, and then the permanganate solution is run in *drop by drop* from the burette, with constant stirring, till the deep blue of the indigo changes to a clear yellow, and the moment this takes place we note the quantity of permanganate used. We will call this A. Next we repeat exactly the same process with the indigo and sulphuric acid alone, and we will call this quantity B. Then subtracting B from A, we obtain the amount of permanganate consumed by the total astringent of 10 cubic centimetres of our tannin infusion. The permanganate acts, of course, as an oxidising agent, oxidising and consuming both the tannin and the indigo; but as the tannin is the most readily oxidised of the two, it is consumed first, and when the indigo is all bleached [decoloured], we may be sure that the tannin is destroyed also. In order, however, to obtain this satisfactorily, the proportion of indigo should be such as to require about twice the quantity of permanganate which should be consumed by the tannin alone. Thus, if the indigo alone requires 10 cubic centimetres of permanganate to decolourise it, the indigo and tannin infusion together must not take more than about 25 cubic centimetres, and if it does so the tannin infusion must be diluted accordingly, or a less quantity employed.

"The next step is to ascertain the proportion of gallic acid and impurities in the sample. To this end we mix 100 cubic centimetres with 50 cubic centimetres of the salted gelatine solution, and *then*, after well stirring, add 100 cubic centimetres of the salt and acid solution, and

leave the mixture standing for some hours, or all night, and then filter it through filtering-paper. The filtrate should be *perfectly* clear. If we now test, say 50 cubic centimetres of this filtrate with permanganate and indigo, as before, we shall obtain the amount of permanganate required for the gallic acid and impurities alone, since the tannin has been entirely precipitated, and the gelatine has so trifling an action on the permanganate that it may be safely neglected. To make the working clearer we will take an example from Mr. Löwenthal's paper:—

Ten grains of sumach were boiled in ¾ litre of water, and after cooling, were made up to 1 litre.

1·10 c.c. sumach infusion 25 c.c. indigo solution	consumed	16·6 c.c. permanganate.
The same repeated	16·5	,, ,,
	33·1	
Indigo alone	13·2	
Total permanganate for 20 c.c. sumach	19·9	
2·50 c.c. filtrate from the gelatine ..... 25 c.c. indigo solution	consumed	11·2 c.c. permanganate.
The same repeated	11·1	,, ,,
	22·3	,,
50 c.c. indigo alone	13·2	,,
Gallic acid and impurities	9·1	,,

"Now, deducting 9·1 cubic centimetres from 19·9 cubic centimetres, we have 10·8 cubic centimetres as the permanganate equivalent to the tannin of 20 cubic centimetres of sumach infusion, or 0·2 gramme of dry sumach. If it be desired to compare two sumachs, these proportional numbers are all that is necessary, and indeed it will be quite safe to use them for comparing sumach with galls or pure tannin. In the same way bark may be compared with bark, and valonia with valonia, but it will not be safe to attempt by this means to compare bark with sumach or with valonia, because the dif-

ferent species of tannin consume different proportions of permanganate."

Mr. Hewitt on Löwenthal's Method.—With a view to testing the accuracy of the results obtained by Löwenthal's method, Mr. F. W. Hewitt, of the Royal College of Chemistry, made a series of experiments with different tanning materials, and communicated the results of his labours to the journal referred to,* from which we make a few extracts. Mr. Hewitt observes:—"1. The indigo-carmine solution employed must be quite free from suspended or undissolved matter. A convenient strength to use is such that 20 cubic centimetres thereof shall require about 12 cubic centimetres of permanganate solution (1·5 gramme of the salt to the litre). 750 cubic centimetres of water should be used to dilute this quantity of indigo, as the changes of colour from the blue to the various shades of *green*, and lastly *yellow*, are more distinct than if the solution be more concentrated. A moderate amount of dilute sulphuric acid added to the indigo does not influence the reaction." Mr. Hewitt prefers, instead of using a beaker glass for the titration of the permanganate solution, to employ a large flask, capable of holding about 48 ozs., and to agitate the contents by giving them a rotary motion during the reaction. He further observes, that if the permanganate solution "be run from the burette somewhat quickly, a slightly different reading can be obtained from that which is obtained when it is slowly introduced. When the approximate amount of permanganate required is known, one cubic centimetre may be run in at a time, and the flask shaken, as before, about six times between each addition of permanganate. In this manner more uniform readings are obtained." Mr. Hewitt says, that in precipitating the tannin by gelatine, Löwenthal's dilute acid solution "must not on any account be deviated from, as a more concentrated acid (hydrochloric) would act upon the permanganate and liberate chlorine."

Mr. Hewitt states that one objection to Löwenthal's method is that the gelatine solution requires a certain

* *Tanners' Journal*, April, 1877.

amount of permanganate in the presence of free acid. This he observed by adding a little permanganate to an acidulated aqueous solution of gelatine, when the colour was discharged. "If the same tannin infusion be used in duplicate analyses with the same gelatine, I obtained very clear results, even when slightly different strengths of indigo were employed. Both indigo solutions, though of only slightly different degrees of concentration, should be previously titrated with permanganate solution."

Mr. Hewitt gives the following result of his analyses, in conducting which he employed the *same* infusion of tannin and the same gelatine solution. The results are expressed in accordance with Löwenthal's proposition—namely, in percentage of oxidisable matter:—

I. *Sumach Infusion.*

	1.	2.
Tannin	45·3	45·8
Oxidisable matter, not tannin	54·7	54·2

II. *Galls Infusion.*

Tannin	75·2	75·0
Oxidisable matter, not tannin	24·8	25·0

III. *Oak-Bark Infusion.*

Tannin	87·3	87·3
Oxidisable matter, not tannin	12·7	12·7

In pursuing his experiments further, Mr. Hewitt found that the tanning material under examination should be boiled several times, with successive small portions of water, in order to obtain constant results in the determination of the respective amounts of oxidisable matter present, and that a simple infusion in hot water did not afford such results. He also urges that the sample to be examined should be intimately mixed, so as to obtain a fair average in the portion to be examined. "In reference to the salted gelatine solutions," says Mr. Hewitt, "if the gelatine be not heated for a sufficient length of time on

the water-bath, with common salt solution, it assumes, on cooling, a jelly-like condition, and the solution from the precipitate which is formed when the gelatine solution is added to the tannin infusion, filters neither quickly nor clearly. This can, however, be entirely obviated by using a gelatin solution of a perfectly fluid consistency." He also says that he has not found any advantage in allowing the precipitate to stand for several hours, as recommended by Löwenthal, to obtain a perfectly clear filtrate. He thinks that half an hour is sufficiently long, whereby the operation of testing tanning materials is considerably accelerated. The following results were obtained by Mr. Hewitt from the same sample of sumac, intimately mixed, and completely extracted. The strength of each of the four respective infusions being about 5 grammes to the litre.

	1.	2.	3.	4.
Tannin	59·5	59·2	59·64	59·68
Oxidisable matter, not tannin	40·5	40·8	40·36	40·32
	100·	100·	100·	100·

"It will, I hope, be allowed," observes Mr. Hewitt in conclusion, "by your practical readers, that a method which yields such results under the conditions which I have endeavoured to trace may well be called a useful method."

The above results, based upon a careful and exhaustive series of experiments, clearly indicate the usefulness of Löwenthal's method of testing tanning materials, especially when subject to the modifications which Mr. Hewitt has so ingeniously introduced. The difficulty which sometimes arises, however, of separating minute particles of tanno-gelatine, which obstinately remain suspended in the filtrate, and thereby affect the accuracy of analyses in some degree, has frequently been a source of trouble in this and other cases in which gelatine has been employed to precipitate tannin. To overcome this, Prof. H. R. Procter hit upon the happy idea of mixing kaolin (china clay) with the liquid before filtration, the effect of which,

he says, "was instantaneous and complete. A perfectly clear filtrate was obtained without any of the tedious waiting which before was necessary, and it was not only free from tannin, so far as I have been able to ascertain, but also nearly so from gelatine, so that it only gives the faintest cloudiness with tannin solution." Kaolin is constantly used by photographers to remove the brown colour derived from the action of nitrate of silver upon albumenised paper, from their *sensitising* solutions, which it does effectually and instantaneously. A pinch or two of kaolin is put into a pint of discoloured sensitising solution, the bottle well shaken, and the solution at once filtered, when it passes through the filter perfectly bright and colourless.

Prof. Procter on Löwenthal's Method.—Prof. Procter* thus describes the system he adopts in working Löwenthal's method:—"I employ permanganate of the strength of 1 gramme per litre, and solution of the purest indigo-carmine of 5 grammes, with 50 cubic centimetres of concentrated sulphuric acid per litre, using a 25-cubic centimetre burette, and 20 cubic centimetres of indigo solution, which consumes about 15 cubic centimetres of permanganate. The quantity of astringent used must not require more than the remaining contents of the burette. The titration is performed in a white basin, as recommended by Kathreiner, with about three-quarters of a litre of good water, which it is best to measure approximately, so that if it contains any impurity which affects the permanganate it should be constant, and thus eliminated with the indigo. The titration is finished when the pure yellow liquid shows a faint pinkish rim. This acid reaction, which is of extraordinary delicacy, is due to Kathreiner, and is quite different to the pink caused by excess of permanganate, being an effect common to all pure yellow liquids. I do not find it needful to make the titration so slowly as has been advised; the permanganate may be dropped rapidly, with vigorous stirring, so long as there is large excess of indigo, but as soon as the bottom of

* *Journal of the Society of Chemical Industry.*

the basin can be seen through the solution it must be added very cautiously and with occasional pauses, to allow time for its complete mixture through so large a mass of fluid.

"I make my infusion of such a strength that I can employ 5 cubic centimetres of the original liquid for each titration. This is repeated twice, and the results added together and denoted *a*. I then take 50 cubic centimetres of the infusion, and add 28·6 cubic centimetres of a freshly made solution of Nelson's gelatine of 2 grammes to 100 cubic centimetres. After shaking, the mixture is saturated with salt, which brings the volume up to 90 cubic centimetres, and 10 cubic centimetres of dilute sulphuric acid (containing one volume of concentrated acid in ten) and a teaspoonful of pure kaolin are added. It is best to do this in a flask in which it can be well shaken, after which filtration may be at once proceeded with. Ten cubic centimetres of this filtrate (= 5 cubic centimetres of the original infusion) are employed for a second pair of titrations, which are added as before, and the result denoted *b*. If, further, *c* be the quantity of permanganate required to oxidise 10 cubic centimetres of decinormal oxalic acid, and 10 grammes of substance have been employed to one litre of infusion, $c : (a—b) :: 6{\cdot}3 : x$, where x is the percentage of tannin expressed in terms of crystallised oxalic acid. For the present I invariably calculate my results in this way, since we do not actually know the relation of any single tannin to permanganate, even Neubauer's number for gallo-tannic acid being probably too high, and Oser's for quercitannic acid being only a fair approximation. It happens, moreover, that this last equivalent (62·36) does not differ from that of oxalic acid (63) more than the ordinary limits of error of such estimation, and the substitution is therefore of no commercial importance, while it is surely better to employ a standard which is easily and exactly verified than one which is certain to be modified by further research, and so to run the risk of either having our results made useless for further comparisons or of establishing a false and arbitrary equivalent. What is

wanted for practical purposes is not the absolute weight of tannin in the various materials, but only a means for the relative comparison of two samples of the same materials, cross comparisons of different tannins being simply delusive."

Ramspacker's Method. The Tannometer.—The following is Dr. John Watts's description of Muntz and Ramspacker's apparatus, called a *tannometer*, for estimating tannic acid, by which the actual tanning power of any tanning material may be determined—"The apparatus may be briefly described as a shallow gun metal drum of about 200 cubic centimetres capacity, permanently closed at one end by an india-rubber plate, and capable of being closed watertight at the other end by a piece of depilated hide, when clamped upon a stand over which the skin has been previously stretched.

"The drum is perforated at the side with a screw, to admit the introduction of the tanning liquor, and is fitted above with a screw-piston to compress the india-rubber disc. When the piston is lowered the liquor is forced through the skin, while the latter retains the whole of the tannic acid. The density of the liquor is taken before and after the operation by means of a very fine hydrometer graduated to a special scale, when the difference expresses at once the percentage value of the liquor operated upon. In order to compare the results of this tannometer with Hammer's table of percentages of tannin in solutions of different densities, and to compare both with the results by evaporation, a number of experiments were undertaken by the inventor. The percentages only indicate the value of the particular sample under examination. The numbers in the first column were obtained by taking the specific gravity at 15° C. (59° Fahr.) before and after removing the tannin and obtaining the percentage equivalent from Hammer's table. The third column was found by evaporating 25 cubic centimetres in a platinum dish before and after the removal of the tannin, and drying the residue for three or four hours at 100° C. (212° Fahr.).

	By Specific Gravity.	By Tannometer.	By Evaporation.
Cube Gambier	41·45	40·44	47·43
Bale „	42·24	30·50	49·02
Cutch	47·70	44·60	52·16
Valonia	25·32	25·32	26·30
Myrobalans	32·30	30·28	31·08
Mimosa bark	31·44	30·16	31·72
Blue galls	60·60	59·10	—
Green „	53·40	52·41	57·90
Sumac	17·10	18·00	19·55
Divi divi	34·50	33·94	35·20

Casali's Process.—This is founded on the fact that a neutral solution of sulphate of nickel, containing a salt of ammonium, completely precipitates tannin from its solutions, forming flocks which easily collect together. He prepares his standard solution as follows :—2·89 grammes of pure sulphate of nickel, previously dried at 518° to 572° Fahr., are dissolved in boiling water with the addition of a few drops of sulphuric acid, and 100 cubic centimetres of a 30 per cent. solution of sulphate of ammonia are added. One-half the mixture is mixed, drop by drop, with ammonia, until it assumes a violet-blue colour. The other half is then added, and the whole diluted to one litre. The solution is not affected by glucose, glycerine, tartar, or alkaline oxalates and succinates. One c.c. precipitates 0·01 gramme of the tannin of galls, or 0·01497 gramme of the tannin of oak bark. To determine the tannin, the sample of ware—20 grammes, if it be supposed to contain 6—10 per cent., and 10 grammes or less if it contains more—is powdered and extracted with water at 168° to 176° Fahr., so that the total bulk of the filtered solution may make up $\frac{1}{10}$th litre. Ten c.c. of it are mixed with five c.c. of alcohol, and the standard solution is allowed to flow into it, drop by drop, from a burette. As an indicator, he uses slips of filter paper steeped in a mixed solution of perchloride of iron and copperas. From time to time a drop is placed on a little square filter-paper, and allowed to pass through this upon the iron paper. The reaction is complete when a drop no longer blackens this paper.

Standard Method. International Association of Leather Trades' Chemists.—There are few substances which present so many difficulties in the way of their accurate estimation as tannin. Although the subject of the accurate determination of the amount of tannin in any given substance has received the attention of chemists for a great number of years, it must be confessed that no absolutely reliable method has yet been discovered.

One of the chief difficulties in dealing with tannin is its high molecular constitution, which permits of its being decomposed very readily, forming fresh compounds which introduce further complications into the proper estimation of the original tannin. One of the earliest methods of estimating tannin was to precipitate the tannin with a standard solution of gelatine; but this and other methods involving the use of gelatine were found to be only approximate in their results, and not sufficiently reliable for employment in commercial analyses. It would occupy too great a space even to mention the many different processes, gravimetric and volumetric, which have been tried, without success, to solve this problem. Some methods which are satisfactory with one particular tannin material utterly fail when dealing with another of a different class. It is obvious that some means of estimating tannin had to be employed, and, in consequence, chemists adopted methods of tannin analyses which their own fancy dictated, the result being that great discrepancies in the percentage of tannin in the same sample occurred when analysed by two different chemists.

As the subject of tannin analyses grew in importance, it became imperative that a standard method should be devised to be employed in all tannin estimations, which would at least procure concordant results, if not accurate determinations of tannin. With a view to establishing such a method, a conference of those principally interested was called in London in 1897, the result of which conference was the formation of an International Association of Leather Trades' Chemists, who agreed to adopt one

"standard" method in all tannin estimations. The method which was agreed upon is known as the "hide-powder filter method;" but at the annual meeting of the association, additions to and alterations in the originally adopted method are constantly being made. The hide-powder filter method consists in detanizing the tannin solution by means of hide powder placed in a "bell form" of filter through which it is syphoned. The method is carried out as follows: First, the infusion of the tannin material, or the solution of extract (the strength of these depends on the material under examination, an infusion is usually made with between 20 to 40 grms. of the material, according to its richness in tannin. An extract solution is made between 12 to 20 grms. of extract. In both cases 1 litre of the liquor is made), is filtered through what is known as the "candle" filter, which is used largely in bacteriological laboratories. The vacuum pump is used to facilitate this filtration, the object of which is to get rid of all insoluble matter.

It is usual to filter only about half of the litre, the whole having been previously well shaken. 50 c.c. of the clear filtrate is taken for the estimation of the "total soluble" matter. This is done by evaporating to dryness in a weighed porcelain basin on a water-bath, and the residue is afterwards dried in an air oven at about 105° C., then cooled in a desiccator and weighed. A vacuum oven is preferable for drying the residue, as it lessens the tendency of the tannin matters to oxidise, thereby gaining in weight.

The "total soluble" residue contains both tannin and non-tannin matters, so that it becomes necessary to separate them in order to estimate either the "tannin" or the "non-tannin." This separation is carried out on a fresh portion of the solution. The standard method consists in absorbing the tannin matters present in the liquor by means of the hide-powder filter already referred to; and regarding the filtrate (which has become decolourised in passing through the hide powder) as containing non-tannin matters, a measured quantity is taken,

usually 50 c.c. The first 30 c.c. from the filter is rejected as containing soluble matter from the hide powder, and the second 50 c.c. is evaporated to dryness in a weighed porcelain basin, and treated exactly as in the case of the estimation of the total soluble matters. The difference in the weight between the total soluble residue and the non-tannin residue represents the amount of tannin in 50 c.c. of the original tannin solution, and by a simple calculation the percentage of tannin matter in the original extract or tannin material can easily be determined. The water contained in a tannin extract is determined by drying a weighed quantity of the extract at 110° C., and weighing and drying alternately until the weight is found to be constant. The residue from the moisture determination is termed the "total dry matter." The difference in the weights between the total dry matter and the total soluble matter represents what is termed "insoluble at 15° C."

It will be observed from the foregoing that the standard method of tannin estimation possesses only moderate claims to scientific accuracy, and differences in manipulation affect the final results. For instance, the particular manner in which the hide powder is packed in the bell filter has an important bearing on the results.

There are many modifications of the hide-powder filter method, such as the American "shake" method, which consists in treating a definite volume of the clear tannin solution with a weighed quantity of hide powder in a glass tumbler, and the mixture is well shaken at frequent intervals in a machine constructed for the purpose. The mixture is afterwards filtered through an ordinary funnel having a plug of cotton wool in the neck, when the filtrate is found to be completely detanised. In other respects the process is the same as that already described.

The most unsatisfactory feature in all the methods where hide powder is employed is the difficulty of obtaining a regular supply of hide powder of the same quality. Experiments are being made with chrome hide powder prepared from chrome tanned hides, and the results are

said to be more uniform than those obtained with the ordinary hide powder.

In conclusion, it is to be feared that the chemistry of the tannins is not yet fully understood, and when more light is thrown upon their chemical constitution, doubtless more scientific methods of analyses will be devised.

CHAPTER IX.

PRELIMINARY OPERATIONS.

Treatment of Green or Fresh Hides.—Method of Salting Hides.—Cleansing the Raw Hides.—Dried Hides.—Softening Dried Hides.—Brain's Process.—Dry Salted Hides.—Wet Salted Hides.—Schultz's Views on the Treatment of Hides.

Preliminary Operations.—Since the *condition* of the raw hides, as they are received by the tanner, influences their preparatory manipulation, it will be necessary to consider them under the three different heads which indicate their condition, namely: 1. Green, or Fresh Hides; 2. Dried Hides; 3. Dry Salted Hides; 4. Wet Salted Hides. The first embraces those hides which are furnished by the slaughter-houses and butchers, and the latter such as are imported from different parts of the world.

Treatment of Green, or Fresh Hides.—Those hides which have been recently taken from the slaughtered animal require but little labour to cleanse from the ordinary "muck" which commonly adheres to them; since the hides are sold by weight, however, it has sometimes been the practice of unfair vendors to augment their weight by purposely saturating them with such filthy matter.

It occasionally happens that the *green hides* of the slaughter-house cannot be at once used by the tanner, in which case, especially in warm weather, the hides are *salted*, so as to check putrefaction. For example, if the hides are required to remain in stock for a week before undergoing the preliminary process of washing and liming, about four or five pounds of coarse salt are spread over

each hide; but if they have to be kept for a longer period about twice that quantity of salt is used. Imported hides, as those from South America, are treated with a still greater quantity of salt, sometimes as much as 20 lbs. being used for each hide, according to the size and the season, the average quantity being about 15 lbs. per hide.

Method of Salting Hides.—The Continental system of salting hides, known as Delande's method, consists in spreading the hides open upon the ground and sprinkling the flesh side with salt, but more liberally at the edges and along the spinal parts. The hides are then folded or doubled lengthwise down the centre; the remaining folds are made over each other, commencing with the shanks; next the peak of the belly upon the back; afterwards the head upon the tail part, and the tail part upon the head, and lastly doubling the whole with a final fold, and forming a square [or cushion] of about two feet. This being done, they are piled three or four together, and left until the salt has dissolved and penetrated their tissue, which is generally in about three or four days. Thus prepared they are sent to market. Skins may be dried, even after having been salted, by stretching them upon poles with the flesh side outwards, and exposing them to dry air in a shady place. Ten pounds of salt in summer, and somewhat less in winter, are requisite for each skin of ordinary size.—*Dussauce.*

Cleansing the Raw Hides.—It is of considerable importance that the hides, before being submitted to the several operations which constitute the tanning process, should be freed from all adhering foul matter, blood, &c.; in short, the hide should be *clean.* This is effected after the horns are removed by first steeping them in water for several hours—from one to twelve hours, according to their condition—and afterwards removing all the filth thus softened or loosened by washing in clean water, a running stream, where practical, being preferable. When the hides are more than ordinarily dirty they must be removed from the soaking bath and scraped with a blunt

tool, Fig. 5, on the beam, trampled upon in water, and finally well rinsed. When a running stream is available it is considered a good plan to secure the hides to a rack, and this being fixed in the full force of the stream, the friction of the water loosens and dislodges the objectionable matter, whereby there is a considerable saving of labour.

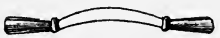

Fig. 5.

Dried Hides.—It will be readily understood that skins which have been deprived of their natural moisture by exposure to the air or the heat of the sun, without undergoing any further treatment, for export purposes, merely require to have the moisture they had lost in drying restored to them to bring them to the condition of *green* or fresh hides. And this is so in fact; but in order to facilitate the absorption of moisture by the indurated or hardened surfaces of the hides without wasting their substance, a certain amount of mechanical treatment is necessary. If the skins could be soaked in boiling water they would very soon recover their normal condition; but as gelatine is soluble in hot water, the skins, by such treatment, would not only lose considerably in weight, but their porous structure—so important to the free absorption of tannin—would become altered, if not destroyed. Dried skins, therefore, must be brought to a pliant state by cold soaking in the first instance, and by subsequent beating, rubbing, and soaking to render them supple.

Softening Dried Hides.—The dried or "flint" hides of Buenos Ayres, River Plate, and other localities, are first thrown into cold water, in which they are soaked from ten to fourteen days, according to their thickness; but after being in soak for several days they are subjected to mechanical treatment by being forcibly rubbed or "broken" with the blunt tool on the beam, after which they are again soaked and then subjected to a process of *beating*, which in most establishments is effected by a machine called the *fulling stocks*, which, by repeated blows of the hammer or toes upon the partially softened skin, alternated by further soakings, eventually reduces the hides to nearly the con-

dition of fresh hides. An illustration of such a machine, as made by Huxham and Browns, is shown in Fig. 6.

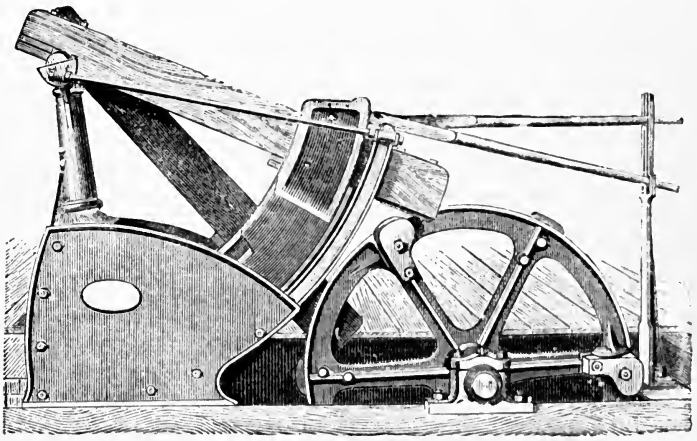

Fig. 6.

Brain's Process.—A process for softening dry hides and puring skins from lime has been introduced by Mr. T. Brain, which appears to have commanded some attention from the trade. In an address to the Scottish tanners, he said, "I have succeeded in making a compound not only *inoffensive*, but emitting a pleasant odour, which I shall be prepared to sell under a registered title, and which for dressing leather is applicable with a little alteration in the use, and washing through clean cold water afterwards, with careful scudding. . . . . Tanning of dressed leather prepared by my process does not require the liquor to be so strong or new at commencement as skins require by the bating or reducing system generally in use. By the old way the pelts have parted with so much gelatine that if they are put into very weak liquor they go on losing gelatine. But by using a moderately strong liquor for a day or two it closes the extremities of the fibrine, consequently the gelatine ceases to flow out, and they are put

into a weak liquor to 'recover breath.' By puring the pelt from lime and not reducing by bate, it retains all the gelatine, and should be well handled in a weak stale liquor for a day, and then shifted to increased strength daily, so that a gain of about 1 per cent. is kept up additionally, commencing at about 6 degrees for dressing and 10 degrees for sole."

Dry Salted Hides, as those from Texas, Pernambuco, &c., are treated much in the same way as dry hides, but are somewhat more readily softened than what are called "flint" hides.

Wet Salted Hides are soaked in water to remove the saline matter, after which they are rubbed on the beam and again soaked, until they are in the proper condition for the lime-pits.

Schultz's Views on the Treatment of Hides.*—"In all the processes, commencing with the soaking and milling or wheeling, through the lime or bate, each pelt must be individually treated; and if the conditions are much varied, more judgment and care will be necessary in their treatment as a whole than if they are substantially alike. In the latter case ordinary intelligence would suffice to perform creditable work. This degree of intelligence is all that the employer has a right to expect, and hence the importance of making as light drafts upon the brain power of his men as possible, by making the labour uniform on each piece of stock. How few calf-skin tanners in this country [America] think it important to classify their skins! Do they not work all skins, from six pounds to twelve, in the same pack? Whatever is classed as 'veal' go together; the first selection that is thought of is when the finishers are wanting stock. The packs are then assorted, and the tanned skins are selected out and sent to the currying shop, while the heavy ones are given another liquor. This is beginning at the wrong end: the selection should have taken place before the skins entered the beam house, when the advantages of classification would have been secured all the way through the process.

* "Leather Manufacture." By Jackson S. Schultz.

"In a well-regulated calf or kip-skin yard, from the time the skins enter the tannery they are mated (for reasons hereafter stated), and continue this connection through the whole after tanning process. But how can dissimilar sizes and substances be suitably paired, and so placed, grain to grain, as to fully cover each other? What has been said thus far goes to the advantage of the intrinsic quality of the stock; but suppose some hides or skins are damaged, or partially so? These should by no means be allowed to contaminate the good. They are the sick members, and must be placed in hospital under observation. They may not all have the same disease, and must be placed in different 'wards' or apartments for special treatment. When one thinks of the indiscriminate and forcing processes which valuable stock receives at the hands of many tanners, the inhumanity of the treatment is forced on one's mind. Sick or well, strong or weak, large or small, the same methods, the same trying ordeal, must be passed by all, and that so few should break and fail is a wonder.

"It remains only for me to say a word about the impolicy of working a variety of hides in the same yard. It is not to be denied that some tanners succeed in making good stock out of a variety of hides under treatment at the same time; but this is the exception, and should not be ventured upon by the average tanner. At least one season's or one year's hides should be of one kind, or as nearly so as possible. Buenos Ayres, Monte Video, and Rio Grande are sufficiently alike to be classed together. Central America and Matamoras, and even dry Texas, are possibly similarly conditioned. California and Western may be well treated as similar hides, requiring light treatment; but there cannot be safely treated dry salted and dry flint hides in the same beam house; lime and sweat stock cannot go through together without danger, or certainly with the hope of the most satisfactory results. The best leather is made by tanners who work a uniform description of hide. This is the usual experience, and is based on common sense."

These observations, emanating as they do from one of the most experienced and observant of American tanners, deserve the fullest consideration, and few, we should imagine, will question their wisdom. Of all the members of the trade in any country, Jackson Schultz will ever be held in esteem for his generous desire to promote the welfare of his trade by freely and ungrudgingly making known the results of his own vast personal experience for the benefit even of his competitors—an attribute but seldom, and it must be acknowledged with regret, found in those who follow the art of tanning in this country. Indeed, the reticence, "closeness," or so-called "conservatism" of the tanning trade in this country are, we think, to be deplored; for were the followers of this great art to assist each other by the interchange of ideas, and by making known such modifications of processes as may from time to time have proved successful, not only individuals, but the whole fraternity, as well as the general public, would be the gainers.

CHAPTER X.

DEPILATION, OR UNHAIRING SKINS AND HIDES.

Depilation by Lime.—Properties of Lime.—Storing the Lime.—Liming.—Single Pit Method.—Working in Rounds.—Continental Method of Liming.—Supposed Disadvantages of the Lime Process.—Dr. Davy on the Action of Lime on Animal Matter.—Working on the Beam.—Rounding the Pelts.—Depilation by Sweating.—Cold Sweating.—Depilation by Acids.—Depilation by Saccharine Matter.—Depilation by Caustic Soda.—Depilation by Bisulphide of Calcium.—Depilation by Charcoal.—Depilation by Sulphide of Sodium.—Palmer's Process.—Beck's Process.—The Pullman-Payne Process.

Depilation by Lime.—The removal of the hair from skins and hides, called *depilation*, or *unhairing*, and which may also be termed *dehairing*, is performed by several different processes, but that which finds most favour in this country is that known as the *lime process*. When a fresh skin is allowed to remain for a certain length of time in a mixture of caustic (that is fresh) lime and water, the *cuticle* or epidermis, together with its hair, readily separates from the *cutis* or true skin, while at the same time the fatty and fleshy matters of the under portion of the skin become easily separable by the operations of the *fleshing knife*. During the soaking in the lime-pits, the fatty matters become partially converted into an insoluble lime soap, whereby the fleshy portions are loosened and may be readily scraped from the under surface of the true skin.

Depilation by lime is the oldest method known, and although it possesses certain disadvantages, it is still more extensively adopted than any other method of unhairing. The lime is made into what is called *milk of lime*, by

mixing recently slaked lime with water in varied proportions, the weakest mixture being that in which the hides are first soaked, and in which they are allowed to remain for one or two days, after which they are transferred to another pit containing a stronger lime mixture, and so on, through successive steeps of increasing strength until the scarf skin, with its hair, readily yields to the touch, which is generally the case in from two to three weeks, according to the texture and condition of the hides and the temperature of the atmosphere. As in all other tanning processes, however, there is a great diversity of opinion; whether the process of liming should be conducted slowly in weak liquors, or as quickly as possible in strong liquors, is yet an open question. The old tanners used to employ very weak liquors, in which the process of depilation occupied several—sometimes many—months for its completion. Now, however, we have been taught to believe that so long a soaking as even three weeks causes a loss of gelatine; some tanners, therefore, prefer using strong liquors, whereby they are enabled to unhair the hides even in so short a time as about seven days; and indeed from the very nature of the operation—that of removing the cuticle and hair chiefly—this method of depilation would appear not only the most scientific, but also the most practical, if conducted with great care. It is found also that the pelts, after treatment in the strong limes, are swollen to their fullest extent, and that, after tanning, they give greater weight than those which have been treated for a longer period in weaker lime liquors. When we reflect that the loosening of the epidermis on the one side of the skin and the fleshy matters on the other are *the* objects of liming, if this can be effected in such a way that the true skin is not subjected to *any* action of the lime it will undoubtedly be an advantage, since the raising or swelling can be effected by less objectionable or more suitable materials than lime. The nearest approach to a perfect system of liming would appear to be that which is quickest, for in this case the gelatine of the skin is less liable to be dissolved than when subjected

for a lengthened period in weak liquor. It almost appears contrary to principle to steep hides in spent or weak lime at all.

Properties of Lime.—Before giving the various proportions of lime employed by different manufacturers, it may be well to consider what is the nature of lime and to what extent it is soluble in water. When chalk or limestone (carbonate of lime) are calcined at a high temperature, water and carbonic acid gas are expelled, and *oxide of calcium*, or *lime*, remains behind. If this lime be again exposed to the air, it readily attracts carbonic acid, and again becomes converted into carbonate of lime, and assumes the form of a white powder. If a lump of fresh lime be sprinkled with water, in a few moments a hissing and crackling sound is heard, the lime splits up in all directions, with evolution of steam, the heat engendered being so great as to be capable of igniting wood. The lime absorbs about 31·0 of its weight of water, and falls into a dry, white powder called *hydrate of lime*—a chemical compound of oxide of calcium (lime) and water. It is an ascertained but remarkable fact, discovered by Dalton, that lime is more soluble in cold than in hot water; that is to say, water at 60° Fahr. dissolves $\frac{1}{778}$, while at the temperature of 212° Fahr. (the boiling-point of water) it only takes up $\frac{1}{1270}$. Mr. R. Phillips ascertained that water near the freezing-point took up about one-seventh more than water at 60° Fahr., and nearly double that of boiling water.

The solubility of lime at the several temperatures is as follows:—

A pint of water at	32°	Fahr.	dissolves	13·25	grains	of	lime.
„	„	60	„	„	11·6	„	„
„	„	212	„	„	6·7	„	„

From this it will be seen that in *cold* weather the strength of the lime liquors (if an excess of undissolved lime be present in the lime-pits) will be greater than in hot weather. Since, however, chemical action is always more vigorous in warm than in cold temperatures, the

weaker solutions of lime would be fully as active in summer as the stronger liquors in cold weather; doubtless the colder temperatures, however, would be less injurious to the pelt.

As to the proportion of lime which should be employed for fifty hides, there seems to be great diversity of opinion. While some manufacturers use from 2½ to 3 bushels for each pit, others have been known to employ more than twice as much. About 2 lbs. of lime for each hide is considered a good proportion.

Storing the Lime.—Bearing in mind that lime deteriorates by absorption of carbonic acid from the air, it requires to be protected from its influence as much as possible. The lime should be kept in a dry closed shed, away from contact with timber; and in order to protect the bulk from the air, it is sometimes the practice to sprinkle the pile with a little water, to slake the lime on the exterior surface, which falls to a powder and acts as a covering to the rest of the heap. Another method of treating the lime is to place it in a large pit and to slaken it with water, and then to cover the whole with a small quantity of water, finally covering up the pit with hurdles and matting. The thick paste of caustic lime thus formed is taken out by shovelfuls at a time as required, and the pit again closed. In this way lime is said to be preserved in a caustic state for a considerable time, which would doubtless be the case.

Liming.—There are two methods in practice for carrying out the process of liming, namely, 1. *The Single Pit Method;* and, 2. *Working in Rounds.* In the former, the same pack of hides is treated in a single pit, with additions of fresh lime from time to time, and in the second the hides are first placed in a weak lime or old lime liquor, and successively steeped in stronger liquors, until the epidermis yields to the touch.

Single Pit Method.—The complement of lime and water being introduced into the pit, the hides are immersed one by one, care being taken to spread them out as flat as possible, until the entire number is immersed. After three

or four hours they are handled or removed from the pit, being piled one over another in a heap, after which they are then returned to the pit as before; after a few hours they are subjected to a second handling on the first day. The handling is effected by means of blunt-pointed hooks (Fig. 7). On the second day, the hides are again drawn,

Fig. 7.

and allowed to remain in a heap as before for an hour or so, during which time the lime at the bottom of the pit is gently stirred or *plunged*, and the hides are again placed in the pit. They are subjected to this treatment during the first three or four days, by which time they will have become considerably swollen. They are now again drawn and placed in a heap as before, and a fresh quantity of slaked lime is added and stirred up with the lime already in the pit; the hides are again immersed, and the handling and stirring of the liquor repeated once a day until the expiration of about twelve or fourteen days from the commencement, by which time they will generally be in a condition for unhairing. The same lime liquors, with additions of fresh lime periodically, may be used several times, or until the liquors give indications of being charged with ammonia, when the pits must be cleaned out.

Working in Rounds.—This method is much adopted by some tanners, and consists in working a series of pits containing lime liquor of different degrees of strength. The green or fresh hides are taken from the water-pits and immersed in the old or spent lime-pit, being handled as before; and from this pit they are shifted to the next or stronger lime, and so on until they have passed through the whole series of three or four pits. Each of these pits being strengthened by fresh additions of lime, the last pit becomes the first in the next round, and so on until the liquors become surcharged with ammonia, when they are

cleaned out and recharged with fresh liquor. When this system is adopted it is necessary to employ pits close to each other to save unnecessary labour.

Continental Method of Liming.—The method of liming, as practised on the Continent, is thus given by Dussauce: "In some parts, as in France and Belgium, well-bound tubs are preferred. The number of these varies from five to twelve, and the solution is then so arranged that there is a regular increasing gradation of density from the first to the last, even where the greatest number is taken advantage of. The first of these, usually called the *dead vat*, contains very little caustic lime, and this is the one to which the hides, after washing, are exposed in commencing the operation. Here they remain from one to three days, according to circumstances, and during this period they receive a handling at regular intervals, some twice and others three times a day. . . . . Before the reintroduction, the contents of the vat are well agitated, with a view to distribute any undissolved quicklime through the liquid, so that there be no partial or undue effect exercised on the skins. The workmen likewise contrive to spread out the latter in the vat as much as possible, and so every part has the same exposure to the lime. In the dead vat, however, there is very little if any quicklime undissolved. After remaining the allotted time in the first vat they are transferred to the second, which contains a stronger liquid, or more lime, and left in this, with occasional overhauling, for a few days, after which they are put into the third, and so on, till the hides ultimately arrive at the last vat, which contains the fresh lime. In operating in this rotation, the dead vat of one batch of hides becomes the *live* one of the next, and so on in succession. The time which skins take for thorough liming varies according to their weight and texture. Thus the lighter skins, as of the sheep, are sufficiently acted upon in three to five days, but ox hides, kips, and calf-skins require two to three weeks, according to the season. . . . . In many parts of the Continent, however, the operations preparatory and conductive

to the depilation last two or three months, but in these cases the skins are partly swelled, so that, for this special treatment, they do not require so much attention in the succeeding stages. The quantity of lime which is used by the different tanners is somewhat various, and dependent upon the size of the hides, but the average is from 18 to 24 gallons of freshly burnt fat lime—3 to 4 cubic feet measure—for 100 hides of average size." Sometimes hides are limed by suspending them from poles in a deep lime-pit, whereby considerable time is said to be saved and much less handling required.

Supposed Disadvantages of the Lime Process.—While the process of *liming* hides and skins possesses the advantages of simplicity and economy, on the other hand, in the opinions of some persons, it presents many important disadvantages, which render its employment objectionable. This view is held more especially on the Continent. The action of the lime is stated to cause a portion of the membranous matter of the skin—which, were it not removed, would enter into the substance of the leather—to be dissolved, whereby a certain loss is sustained. Again, liming renders the surface of the hide unequal, and by entering the cellular structure of the skin, retards the action of the tan and causes it to act ununiformly. That this latter effect is produced there is no doubt whatever, but as to the former, the researches of Dr. John Davy,* conducted at Malta in 1829, prove that lime has no injurious action upon animal tissues.

Dr. Davy on the Action of Lime on Animal Matter.—"It is commonly asserted and believed that lime exercises a corroding, destructive influence on animal matter in general, and that animal bodies exposed to its action rapidly decompose and disappear. Accordingly, it has been almost invariably recommended to add this earth to graves in instances in which rapid decay is considered desirable, as on the occasion of the crowding of grave-pits with dead bodies during the prevalence of pestilential diseases. From

* *The Chemist*, vol. i. New Series, p. 227.

the results of many experiments which I have made with lime on animal substances, I have been compelled to come to the conclusion that this opinion is not well founded in fact; indeed, that it is altogether erroneous. The experiments were commenced in Malta in the summer of 1829, and they were carried on during the following year. The method observed was to immerse the animal matter for trial in cream of lime, or rather a paste of lime, contained in a wide-mouthed bottle, well corked and covered with cerate cloth to exclude ingress of atmospheric air and to preserve the lime in its caustic state. One of the first experiments tried commenced on the 27th of August. Portions of various textures were immersed, as mentioned above. They were taken from a subject in a state of incipient putrefaction, and they exhaled a fetid smell. On immersion in the lime and water, as might be expected, they gave off a strong ammoniacal odour. They were first examined on the 24th of September; they were then all in excellent preservation, swollen, but not corroded nor their delicate tissue injured." At the expiration of seven months, namely in the May following, the animal substances were again examined, and were found to be much in the same state as before, "the texture of each part distinct, and the part, as a whole, easily distinguishable." After being left undisturbed for nearly two years they were again examined, when considerable change had taken place; the cuticle had become soft and transparent, and many other parts had become undistinguishable.

In a second experiment, "commenced in the beginning of October, portions of skin, intestine, cellular tissue, muscle, tendon, &c., were similarly treated. The results were examined on the 5th of May following. Then, on opening the bottle, an ammoniacal, but not putrid, smell was perceptible. The parts were found well preserved, excepting the fatty matter contained in the cellular tissue, which had become opaque, white, and friable, from combination with the alkaline earth and conversion into soap. The tendon was somewhat distended and rendered more

transparent, but not gelatinised; and so also the cutis, the last being deprived of its cuticle and hair." Dr. Davy found that "after animal substances have been subjected to the action of lime, they ceased to be putrescent; they resisted putrefaction, whether placed in air or plunged and kept in common water. . . . . A portion of the cutis similarly treated, placed in confined air in a bottle, after a whole month emitted no unpleasant odour and appeared to be unchanged. I have observed," continues Dr. Davy, "that the cuticle, nail, and perhaps hair, are to be excluded from the list of animal substances not materially altered by the action of lime. On the cuticle its action is powerful, and, I apprehend, in consequence of a chemical combination between them being formed."

Dr. Davy finally arrives at this conclusion, as the result of a great number of experiments:—"*That lime does not exercise a destructive corroding power on animal substances generally*, nor one promoting their decomposition, but on the contrary, a preservative and decidedly antiseptic power, arresting putrefaction even when commenced, and retarding decomposition."

From the foregoing observations, based upon a series of experiments conducted with great care during a period of several years, it would appear that however objectionable the presence of lime may be if not carefully eliminated by bating, by dilute acids, or other means, it has no injurious effect upon the *cutis vera*, or true skin, which, when tanned, constitutes leather. Assuming Dr. Davy's deductions to be correct, the hypothesis that the liming process, fairly conducted, reduces the weight of the hides by acting upon and dissolving a portion of the gelatinous tissue of the pelt, must be fallacious. It is easy to understand that after several weeks' immersion in the lime-pit the fatty matters of the hide enter into combination with the lime, forming a lime soap, and that the cuticle and even the hair will yield to the action of the lime; but from Dr. Davy's observations it would appear that the true skin, or pelt, would undergo no change whatever in the milk of lime mixture in which the hides are by custom immersed. The same

cannot, however, be said in respect of hides which are steeped for several days in spent or very weak liquors, since the solvent action of the water upon the gelatine of the hide in these cases would be to a great extent unrestricted.

Working on the Beam.—When the hides have remained sufficiently long in the lime-pits they are examined, and if the cuticle readily separates when plucked by the fingers, they are taken out and removed to the *beam house*, where they are submitted to certain mechanical operations by which the scarf skin, with its hair, is removed from the *grain* side, and the flesh and fatty matter dislodged from the *flesh* side. These operations are termed respectively *unhairing* and *fleshing*.

Unhairing.—To accomplish this operation the skin is laid upon a convex wooden or iron support called *the beam* (Fig. 8), with its flesh side inwards, and the beam man then takes a two-handled tool, called the *unhairing knife* (Fig. 9), the blade of which is blunt, and curved to fit the convex surface of the beam. Fig. 10 illustrates the mode in which the unhairing is performed. The hair is removed very easily by pressing the knife downward with moderate force, when the grain of the skin becomes exposed. The operation of unhairing a hide is performed very quickly, one man being capable of unhairing many dozens in a day.

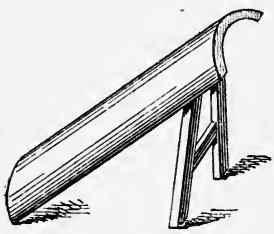

Fig. 8.

Fig. 9.

Fleshing.—After the hair is removed the hides are *fleshed*, an operation which requires to be performed with more care and skill than the last operation, because the knife with which it is effected has a sharp edge, and the action of the tool is to cut or shave off the fleshy matters, whereas the unhairing knife, having a blunt edge, merely

scrapes or rubs the loosened epidermis from the grain side of the corium or true skin. In using the fleshing-knife

Fig. 10.

(Fig. 11) the workman has to be very careful not to cut away any portion of the true skin, his object being only to remove the fat and flesh, so as to leave the corium fully exposed for the after process of tanning. Fig. 12 illustrates the operation of fleshing.

Fig. 11.

After unhairing and fleshing, the *pelts*, as they are now called, are thoroughly washed and once more scraped with a blunt tool to remove any lime or other matters that may still attach to them. This operation is called *scudding*. The *fleshings*, as they are called, are collected and pressed into cakes, and sold to the glue-makers, as also are the ears and all projecting parts, which would be useless when tanned. The hair was formerly used chiefly by plasterers for mixing with mortar, but it is now, after being thoroughly

washed and cleansed, employed in the manufacture of cheap clothing, blankets, and imitation sealskin.

It is not always the case that the fleshing is carried out to the fullest extent, leaving nothing but the true skin to be tanned. Some manufacturers prefer to leave a portion of the flesh attached, so that the butts should present a more mottled appearance, while some of the American

Fig. 12.

tanners merely have the flesh side lightly scraped, by which, of course, greater weight is given to the leather. For the finest quality of bark-tanned butts, however, it is essential that nothing but the true skin should enter the tan pit, and since this, being quite free from fleshy matter, is very easily injured, great care is necessary in the *handling* of the pelts in the earlier stages of the tanning process.

Rounding the Pelts.—It was formerly the custom to tan the hides whole, after unhairing and fleshing, but the system adopted at the present day is to remove with a sharp knife all the inferior parts of the pelt, and to tan the *butts* and *bends* separately. To this end the hide is taken by two men and laid upon a table called the *rounding*

table, it is then doubled from end to end, grain side out; the head is then removed by a cross cut with the *rounding knife* (Fig. 13); the rough edges of the tail end are then cut away or rounded, and the sides or bellies are next cut off, either by one cut or separately. By this method, however, the rounder is unable to see those defects, irregularities, or brand-marks which may be on the under side, and consequently cannot trim the hide in such a way as to make the best of it. It is considered a better plan,

Fig. 13.

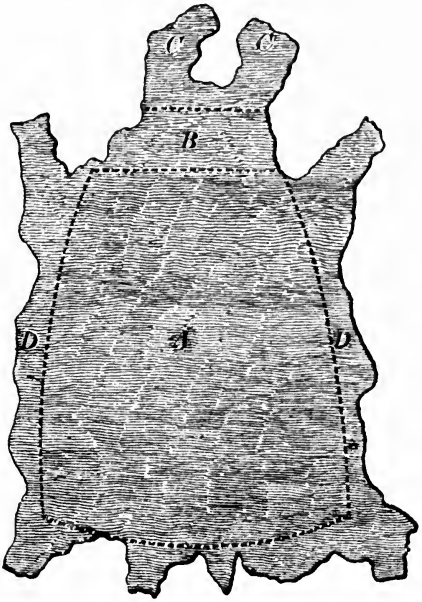

Fig. 14.

therefore, to lay the hide across a wooden frame, or horse, supported by trestles, the frame of which forms a triangular arch. The hides being laid across this, the rounder is able to see all parts of the hide, whereby he

is enabled to perform the operation of rounding with more skill and judgment. The accompanying drawing (Fig. 14) illustrates by the dotted lines the course which the rounding knife should take to separate the various parts from the *butt*, A, or chief part, of the hide. B represents the shoulder, C C the cheeks, and D D the sides or belly pieces. On glancing at the somewhat irregular form of the expanded hide it will be evident that some judgment must be exercised in removing the surrounding parts—which are technically called *offal*—from the butt, so as to make the most of the latter or more valuable part of the hide.

After unhairing and fleshing, the hides sometimes present inequalities as to thickness, and in order to render them more uniform, or of an average thickness throughout, the following plan is adopted, but more especially on the Continent: The hides are rubbed with a smoothing or polishing stone, which is a tool made of sandstone interiorly moulded so as to lie parallel upon the beam, and is fixed to a piece of wood furnished with two handles. With this the hide is rubbed to bring the parts as nearly as possible to an equal thickness. By repeated rubbings or scrapings in this way with the stone, alternated by washings, the dirt, fleshy parts, and lime are removed as far as possible before tanning.

Depilation by Sweating.—By this method the cuticle and fleshy matters are loosened from the corium by a process of *putrefactive fermentation*, or slow decomposition. Although this process is more generally adopted on the Continent than in this country, it is employed by some English tanners, and is in some respects, if carefully conducted, preferable to depilation by lime. After removing the horns, the hides are piled in heaps for several days, after which they are laid across poles in a close apartment called a *smoke-house*, heated somewhat above the ordinary temperature by means of a smouldering fire fed with spent tan, which produces no flame, or by steam heat. In this room the hides undergo a slight superficial fermentation, by which the cuticle, with its attached hair, becomes softened. In France one-half of the hide is

first sprinkled with salt and the other half lapped over it, to prevent the putrefaction from injuring the tissue of the skin.

In Germany the hides are first piled in a heap and then covered with spent tan; in a short time putrefaction sets in, but unless great care is exercised the hides are liable to be injured. Another system is to pile the hides on a bed of litter, then to cover them with litter, and allow them to remain for twenty-four hours, after which they are turned over and examined from time to time to ascertain if they are fit for unhairing.

Cold Sweating.—In some parts of the United States a system of *cold sweating* is practised, the hides being exposed to damp air in a close apartment. The air is kept moist by a spray of water, and it is said that in from six to twelve days the hair comes off easily. It is further stated that by this method no putrefaction takes place, but the loosening of the epidermis is due solely to the softening action of the moisture. It is obvious, however, that by the above methods the fatty matters are not in any degree removed (as is the case in the liming process to some extent), consequently these must be dislodged by mechanical means on the beam. The American system of cold sweating is more fully given in another chapter.

Depilation by Acids.—It has long been known that acid liquors have the power of acting upon the roots of the hair and cuticle, so as to render them easily detached from the true skin. In some tanneries dilute sulphuric acid, pyroligneous acid (wood vinegar), fermented barley, rye, or bran, or sour milk are used, the latter agent being adopted by some Parisian tanners. Rye-water and fermented barley are also sometimes employed after the skins have been limed, as a substitute for *bating*. Barley or rye meal in a state of fermentation were at one time much used as a steep for loosening the cuticle and hair, the active agent being the acetic acid formed during the decomposition of the vegetable matter. Sulphuric, hydrochloric, and oxalic acids have each in turn been employed to loosen the cuticle

and hair, thereby enabling them to be removed from the true skin by the process of scraping or working on the beam; but tanners maintain that by their employment the skins are swelled to such an extent as to injure them materially.

The weak vegetable acids are not excluded from practice, more especially in France, Belgium, and parts of Germany. Many of the Paris tanners submit the hides, after they have been soaked in water, washed, and fleshed, to a number of acid vats, in a way analogous to the liming. Generally the series of baths consists of five, which from the first to the last increase in power and efficacy. The first is usually intended to cleanse the hides, the second to soften the hair and epidermis for the depilation, and the other three to swell and give body to the skins. This operation, which is called the *white dressing*, requires a period of five weeks in the summer and six in the winter season. The quantity of farinaceous matter which is taken varies at different establishments—in some cases 145 lbs. of barley-meal, and in others 150 or 160 lbs., are employed. The dressing is generally made by leavening one-tenth or one-fifteenth of the bulk till it becomes sufficiently sour; it is then softened with hot water, and after the whole has become a thick, homogeneous fluid free from lumps, it is added to the remaining quantity of the meal in the vat, and tepid water in sufficient quantity is poured in to fill the vessel. In some cases yeast is added to quicken the fermentation. Eight or nine hides are worked in each vat, and as in the lime process, the weak or first vat passes in succession from one to the other in rotation. The final vat is compounded of 60 lbs. of meal leavened and thinned with water, and left to develop acetic acid for fifteen days. In all of these operations, handling and working the hides on the beam at regular intervals are indispensable. —*Dussauce.*

Depilation by Saccharine Matter.—In 1844 Dr. Turnbull obtained a patent for the employment of sugar as a depilatory. A solution is prepared by dissolving 14 lbs. of coarse sugar in 100 gallons of water, in which the skins

are immersed and allowed to remain for eight or ten days, being handled in the usual way daily. As soon as the hides are sufficiently raised they are removed from the sugar steep and allowed to drain, after which they are immersed in a strong solution of sea salt, which causes the epidermis to contract and become readily detached from the true skin. After washing in clean water the hide is ready for the tan-pit. It does not appear that this process has received much attention, but there is much in its favour—more especially at the present day, when sugar is very cheap—to merit reconsideration.

Depilation by Caustic Soda.—This powerful alkali has sometimes been employed for unhairing skins and cleansing the flesh side from fatty and fleshy matters, which it is capable of doing with great rapidity, but extreme caution must be exercised in its employment. In order to ensure the uniform action of the caustic liquor it is recommended either to suspend the hides in the solution or to continually handle them while in the pit, otherwise the thinner parts of the skin at the edges will be acted upon by the caustic liquor while the bulk of the hide may be but little affected. The caustic soda is prepared by adding recently slaked lime to a boiling solution of ordinary soda crystals in water, with brisk stirring. After a few hours' repose the carbonate of lime forms deposits at the bottom of the vessel, when the clear solution of caustic soda may be drawn off for use.* The solution freely enters into combination with the fatty matters of the hide, converting them into soap, which may be recovered from the bath or pit when the liquor has lost its causticity by adding sulphuric acid to the liquor; this, combining with the soda of the soapy solution, will set the fatty matters free, which after a while will rise to the surface, and may be skimmed off and kept in casks for the use of soapmakers. Although caustic soda as a depilatory has not been much used in England, it is very questionable whether it does not deserve more consideration than has hitherto been bestowed upon it.

* Caustic soda may be obtained in the solid state, as supplied to soapmakers, &c., thereby saving the trouble of preparing it.

Depilation by Bisulphide of Calcium.—This compound of sulphur and lime, commonly called *sulphuret of lime*, in the form of a paste, has been employed as a depilatory for skins and hides, and if carefully applied is very effective and quick in its action. The bisulphide of calcium is prepared either by passing a stream of sulphuretted hydrogen gas into a thick milk of lime, until the latter is supersaturated, or by taking equal parts of sulphur and quicklime, and after slaking the lime as usual, boiling these substances together in water. The paste thus obtained is brushed or painted carefully over the hair side of the hide while spread upon the floor. After the hides have been well soaked, a light coating of the paste is given, but sufficient to reach the surface of the skin. Since the sulphide would readily destroy ordinary brushes or swabs, we should think that brushes might be made with asbestos—a material which would not be so readily, if at all, acted upon by the caustic sulphide. As the skins are brushed over with the sulphide they are laid one above another, hair to hair, about twenty in a pile. After about two hours the position of the skins is reversed by lifting the uppermost pair and laying them by the side of the pack, and upon these the other pairs are placed in succession, when the bottom pair of the first pack becomes the top pair of the second heap, by which a more uniform action of the sulphide is ensured. In about four or five hours from the commencement the skins are in a condition for unhairing on the beam in the ordinary way; they must, however, be previously soaked in cold or tepid water.

It is stated that although the sulphide is so powerful in its action upon the cuticle and hair (which become practically destroyed), no injurious effect is produced upon the gelatine of the pelt. One serious objection to the employment of sulphides in the above operation is the highly offensive and injurious odour which these substances exhale, and which cannot be long endured by the workmen with impunity; indeed, most disastrous effects are known to have resulted from their employment.

The waste lime from the alkali works, which is bi-

sulphide of calcium in a concentrated form, and also the waste lime from the gasworks, which is of the same composition in a less active state, have each been the subject of a patent, the latter being stated to unhair the skins in from four to eight days. If it be a fact, as stated, that the bisulphide of calcium has no effect upon the gelatine of which the true skin, or pelt, is chiefly composed, this substance should prove more economical than the ordinary process of liming, by which a considerable loss of gelatine is said to be sustained, although this is disproved by Dr. Davy, as we have shown. Since the bisulphide of calcium does not *raise* the pelt, this must be effected by after treatment in the dilute acid bath before the hides are subjected to the tanning operation.

Depilation by Charcoal.—This process was patented by Anderson in 1871. Wood charcoal was applied as a substitute for lime, and in much the same way. The hair was effectually loosened, but the process was simply one of putrefaction, as in the ordinary "sweating" processes, while the charcoal acted as a deodorising agent.

Depilation by Sulphide of Sodium.—For sole leather Eitner recommends the following method of applying this powerful depilatory:—Dissolve 4 or 5 lbs. of the sulphide in each gallon of water. Form this into a thin paste with lime or pipeclay. The paste is to be spread evenly over the hair side of the hide, which is effected by one workman pouring it from a pail down the middle of the hide, while another, with a mop or cane broom, rubs it into every part. The hide is then folded into a cushion and set aside. In from fifteen to twenty hours it will be ready for unhairing, when it will be found that the hair is reduced to a pulp, and therefore totally destroyed. In the above concentrated condition the hair would doubtless be destroyed in less than an hour. The hides are now thrown into cold water, to wash away the sulphide and to enable them to plump. The sulphide being highly caustic, it will, if not removed by washing, attack the nails and skin of the workmen, who should be thoroughly cautioned as to its use, otherwise they will soon suffer from "alkaline sores" of a most

painful character. This method of unhairing gives good weight, as also tough and solid leather, but it requires to be used with very great care. If not spread evenly upon the hide, patches of hair may remain upon the pelt, which will be troublesome to remove afterwards. Against the advantages derived from the quickness of this process must be placed the cost of the material and the loss of the hair. Moreover, unless the hides, after being treated by the sulphide, are plumped by steeping in weak lime, the fleshy matters will be difficult to remove on the beam. Raising by acid is also considered necessary, since the sulphide itself has but little plumping effect.

In applying this process to dressing hides, the sulphide is used in a more diluted condition, the hides being suspended in a solution of the sulphide, three-quarters of a pound being used per hide. After suspension in this solution for about twenty-four hours, the hides are in the condition for unhairing, after which they are limed as before, to plump or swell them.

Palmer's Process.—This process consists essentially in subjecting hides or skins alternately to the action of water and to that of the atmosphere. After the hides are cleansed as usual, they may be subjected to this process by placing them in an open wheel or cage, which is caused to revolve, with its lower portion immersed in a tank containing water, whereby the hides are alternately plunged in that liquid, and as they are raised out of the water by the revolution of the wheel, the air has free action upon them. This action is kept up until the hair or wool is ready to remove. After unhairing, the hides or skins are again placed in the revolving wheel or cage, and the operation continued until a "dark colouring matter can be made to exude from them by 'scudding,' when they will be found thoroughly cleansed, softened, swelled, and prepared for the subsequent tanning or tawing by any suitable process." The process is further described as follows: "The hides or skins being well soaked, are then submitted to the action of the open air for about three days, according to the temperature of the

atmosphere; but in no case must it be long enough to generate ammonia, as that would indicate incipient decomposition, and therefore destruction of gelatine. The hides are then returned to the water for about three days, after which they are again exposed to the air, and so on, alternating the immersion and exposure for about a fortnight from the commencement in the case of wet salted hides, when they will be found to unhair or unwool readily; but in the case of the harder and drier descriptions of hides the process will require to be continued, say, from a week to ten days longer. After the hides are unhaired the alternate soaking and exposure to the air is again repeated, once or twice, until, on 'scudding,' the hides are found to discharge a dark fluid, which I term 'suppressed perspiration.' As an indication of the time when the hides have arrived at the stage when this fluid can be removed, it will be found that they give off a very disagreeable effluvium (like that which arises from an over-driven beast), and different from the ammoniacal smell usually given off by hides under treatment. After the complete removal of the said dark fluid, the hides will be found to be fresh, pure, soft, and sweet-smelling, and they will swell in the water and in the subsequent liquors to a better and higher degree than hides treated by the ordinary and more expensive processes. Such swelling of the hides will also indicate the perfect removal of the said dark fluid. The atmospheric temperature which I find best suited for carrying out my process is about 65° Fahr. If the temperature be higher, less time will be required, and if lower, more time.

"The hides prepared as above described can be tanned in a considerably shorter time than when prepared by the known processes, and they will be found to have gained from 100 to 112 per cent. in weight, instead of only from 65 to 70 per cent., as is the case under the ordinary processes of preparing them for tanning. As a preparatory treatment, the skins or hides may be placed in an open drum or cage, which is caused to revolve slowly with its lower portion immersed in a receptacle containing

water, so that the hides are alternately immersed in the water and then subjected to the action of the air, but this arrangement need not necessarily be employed, and where it cannot be conveniently adopted the hides may be at once steeped in tanks for a lengthened time and then exposed to the air as described."

Beck's Process.—In carrying out this process the inventor makes a "water stove" instead of a fermenting stove, but with this difference, that instead of having a hermetically closed chamber, he employs an open vessel, as a pan or basin; he arranges hooks exactly as in the fermenting stove, and upon these the skins are suspended by the feet, side by side, care being taken to keep them perpendicular. The skins being hung up and descending nearly to the bottom of the pan, the latter is filled up with water until all the skins are submerged. Into this "water stove" fresh or beaten skins may be placed. "The prolonged stay of the skins in the water naturally causes the peeling, and when this peeling takes place the skin has not suffered at all in the water; on the contrary, it has gained in value, and the wool is entirely preserved. When the moment for peeling has arrived, it is only necessary to empty the basin or pan; the skins are drained separately, and they can be peeled easily. By this water system I am also enabled, while preserving the skin and the wool, to accelerate more or less the operation of peeling. It is preferable to let the skins follow their natural course, and cold water may be used both in winter and summer. It will be understood that the skins take longer to peel in winter than in summer, but no harm is occasioned by that. If, on the contrary, it is desired to accelerate the operation of peeling, I use tepid or hot water, and I add to the bath any material capable of hastening this operation, such as soap, soda crystals, strained bran, water, &c., provided always that the materials employed are not such as would injure either the skin or the wool.

"I may observe that if care has been taken to put the skins into the water stove perfectly scoured and washed

(by means of what is known as the Puech process, for example), wool can be obtained of a value hitherto unknown. By my process of peeling the leather obtained is not only worth more, but it can be manipulated immediately by the tawer, or it may be salted, and more especially it may be dried without losing any of its quality."

The Pullman-Payne Process.—In 1898 Messrs. Pullman and Mr. S. Payne, of Godalming, patented the method of liming bearing their name, and which appears to have been used with a certain amount of success. The method depends upon the fact that if a hide which has been treated with caustic soda be subsequently treated with a solution of calcium chloride, a double decomposition takes place and lime is formed in the fibre of the pelt, the sodium uniting with the chlorine to form common salt. In practice it was found that better results were obtained if the hides were first immersed in a putrefying soak, this bearing out what was known in liming practice that there was some joint action of bacteria and the alkaline solution which loosened the hair roots in the process. If sodium sulphide is added to the caustic soda, the putrefactive soak is not necessary, but the hair is likely to be damaged, so that the stale preliminary soak is an advantage. The patentees recommend treating the hides in pits, and according to Procter the caustic soda should not exceed a strength of one pound in ten gallons (1 per cent). The hides, or calfskins, remain in this for about forty-eight hours, during which they are once drawn and returned, by which time, if the putrid soaking has been properly done, the hair should be fully loosened. The hides are then drained for two hours and passed into another pit containing a solution of calcium chloride, which should be slightly stronger than the caustic soda, say of about one and a half pounds per ten gallons. The goods remain in this for about forty-eight hours, during which they are drawn once, and are then well washed in soft water (free from temporary hardness), in which they may be kept for some time without injury.

CHAPTER XI.

RAISING OR SWELLING.

Raising.—Bating.—The Bate, or Grainer.—The Pure.—Scudding.—Sulphuric Acid Bate.—Turnbull's Process.—Warrington's Process.—Bating with Barley-meal.—Lactic Acid for Bating.—Formic Acid for Bating.

When the hides have passed through all the foregoing operations, the *pelts* are soaked for a few hours, sometimes for many hours, in water, for the purpose of removing the lime as far as possible. The more lengthened soaking, however, would, we should think, be not only absolutely unnecessary, but certainly injurious, inasmuch as the water would undoubtedly dissolve a portion of the gelatine of the hide, and thus reduce its weight. The next operation to which the pelts are submitted is termed *raising* or *swelling*, in the case of heavy hides, or *bating*, *puring*, or *drenching*, as applied to kips and skins, by which the whole or a greater portion of the lime is removed from the interior of the skin,* the pores become dilated or expanded, and the fibrous structure of the skin is thereby rendered more susceptible of the action of the tan liquors.

Raising.—For this purpose Macbride, in the year 1774, applied very dilute sulphuric acid (oil of vitriol). The hides were immersed for about forty-eight hours in an acid solution composed of sulphuric acid 1 part and water 1000 parts. Since this acid, however, forms an insoluble salt of lime (sulphate of lime) when coming in contact with the lime absorbed by the skin, its employment for this purpose could not, from a chemical point of view, commend itself, although it has been very extensively

* The presence of lime, even in small quantities, not only produces a harsh leather, but it also prevents the free action of the tannin.

adopted. On the Continent hydrochloric acid has been employed for this purpose, and also as a substitute for *bating*, to which we shall have next to refer. A more rational system than either of the above has been much adopted in France, and has found favour in this country with some tanners; this consists in steeping the hides, in the first stage, in spent tan liquors, in which gallic and other vegetable acids have been developed during the process of tanning. These acids, combining with the lime, form soluble salts of the earthy matter, which readily become removed from the skin by the spent liquor in which they are immersed. In this way the lime is effectively, if slowly, got rid of, while the texture of the skin suffers no injury. In France *sulphuric acid* is believed to have an injurious effect upon the pelt.

Bating.—This remarkable and primitive process is generally confined to the treatment of kip hides, calves' and seal skins, by the light leather tanner, and to the skins of goats and other small animals by the skinner. It has for its object the removal of the lime, whereby the skin acquires the peculiar suppleness and pliancy essential to leather of delicate texture.

The Bate, or Grainer, is essentially a lixivium composed of the dung of pigeons and fowls in water. In this unsavoury mixture the unhaired and fleshed skins are immersed for a period of ten or twelve days, or for a shorter period in warm weather. By this process of *bating*, with alternate scraping or *working*, as it is termed, the lime is believed to be converted into a soluble compound, and thus becomes separated from the tissue of the skin, the mechanical treatment doubtless aiding the operation considerably. Dussauce says: "Investigation has shown that the above matters contain an ammoniacal chloride that parts with its chlorine on coming in contact with the lime, and so gives rise to a soluble combination of this base—chloride of calcium—that may readily be abstracted by water. But if this is the *only* result of the noxious process, dilute hydrochloric acid should answer the same purpose. That this disgusting method should still continue to be extensively

practised is disgraceful to modern science. It is stated that in London alone £5,000 used annually to be expended in collecting and purchasing the above materials for the sole use of the tanners of the capital and its suburbs. Although this method of *bating* hides is tolerably effective, yet it is well known to be attended with serious disadvantages, not the least of which is the putrefaction of the bate that is going on during the steeping, and which injures the hides by acting upon the tissue of the skin, reducing its weight in the first instance, and in the second rendering it incapable of yielding the quantity of leather it should doubtless produce did the above changes not occur. Taking the hint from the action of the alkaline chloride in this case, some tanners have attempted to prevent the putrefaction induced by the bating with excrements by avoiding its use altogether, using hydrochloric acid in a diluted state as a substitute. The innovation has not yet become very general in England, although many tanners, especially in Paris, are reported to have practised it successfully, the object of the expulsion of the lime being satisfactorily gained by it, and in addition to this the swelling of the hides also."

The Pure, which is applied to the skins of the lighter kinds of calf, goat, seal, sheep, &c., is prepared from the excrement of dogs, but, unlike the bate or grainer, which is prepared with *cold* water, the *pure* employed by the light leather dressers is employed *warm;* indeed, as hot as the skin can bear without *scalding,* as it is termed. But it is an ascertained fact that the skin of the dead animal can bear no more heat than the hand of a living human being, without suffering irreparable destruction. While immersed in the pure, the skins are repeatedly moved about, and the pureman has to exert the utmost caution to prevent the decomposition which ensues from injuring the skins. The action of the pure is not only rapid but powerful, especially in summer weather.

Scudding.—The workman forcibly scrapes the skin on the beam, which operation is called *scudding,* by which he removes the decomposing agent and the salt of lime

(chloride of calcium) formed during the immersion in the pure; and in order to prevent further decomposition, the pelts are thrown into clean cold water. The bating and puring operations—especially the latter—are considered the most critical of all the operations of the tanner or leather-dresser. The pure, being employed warm, accomplishes in a few hours that which the *bate* requires days to effect. The applications of the bate and pure will be further considered when treating of light leathers and skin-dressing.

Sulphuric Acid Bate.—Sulphuric acid has also been suggested as a substitute for the bate, but while its action is not so marked as when hydrochloric acid (muriatic acid) is used, it must also be remembered, as we have before observed, that sulphuric acid forms an *insoluble* compound with the lime, which no scraping or *working* can entirely remove. This acid, however, in spite of this well-known fact, is generally used for *raising* or swelling heavy hides after liming, and before they are placed in the *handlers* in weak solutions of tan.

Turnbull's Process.—Dr. Turnbull introduced the employment of saccharine liquids for the removal of the last traces of lime from skins as a substitute for the bate. For this purpose 4 or 5 pounds of coarse sugar or molasses, dissolved in 60 or 70 gallons of water, formed the bate. In this process the sugar forms a soluble *saccharate of lime*, which subsequent soaking and rinsing removes.

Warrington's Process.—In 1841 Robert Warrington patented a process in which carbonate of ammonia was employed as a substitute for the ordinary bate for graining skins. The carbonate of ammonia, however, although it converts the lime into a neutral compound, does not eliminate the earthy matter from the hide or skin; consequently it fails to promote the necessary suppleness and softness of the skin, which are the chief objects of the bating process.

Bating with Barley-meal.—As a substitute for the excrement bate, barley-meal, made into a sour liquor, is much used. For 100 lbs. of dry skins, 50 lbs. of coarsely-

ground barley-meal and 5 or 6 lbs. of *soured* dough are taken and intimately mixed with water. *Acetic fermentation* soon follows, and the acid generated forms a soluble salt with the lime in the skins, which becomes removed by subsequent washings.

Lactic Acid for Bating.—Of late years lactic acid has come into favour with the more progressive tanners for bating or drenching. Its use is more desirable when fancy shades are required, as it is stated the skins come out much cleaner and clearer than by the old methods. This is of much importance, as only the clearest skins can be coloured fancy shades, and the fancy shades bring a much higher price than the black leather. The usual process for chrome-tanned calf skins is to use about half a gallon of 50 per cent. lactic acid to 100 gallons of water, or if the skins are lightly limed a little less lactic acid may be used. The skins are bated in a paddle, and water of about 85°–90° Fahr. is used, that is, the water is 85°–90° Fahr. after the skins are in. Before they are put in, the water should be at least 10° warmer.

For sheep skins, a little less lactic acid is used than for calf skins, and if plump leather is desired, the water is somewhat cooler, about 70° Fahr. For goat skins, a "pure" is first used, and then the skins are bated in a solution of 1 gallon of lactic acid to 400 gallons of water, and at nearly 100° Fahr.

Formic Acid for Bating.—Formic acid is now used for de-liming, and also as a preserving agent for sheep pelts. An American plan is, after unhairing, to wash in a weak solution of acid, using two and a half pints of 40 per cent. acid to ten hides. After fleshing and washing, the pack of hides is then washed in a solution of five pints of formic acid in 135 gallons of water, or five pints to 1120 lbs. of pelt. The hides are washed until de-limed, that is, when a cut section remains white when touched with a drop of phenol-phtalein. If the section shows a reddish reaction the bating must be continued. Formic acid is also used as a plumping agent, and for developing "acid" colours in leather dyeing.

CHAPTER XII.

TANNING BUTTS FOR SOLE LEATHER.

Bark Tanning.—Old Methods of Tanning.—Modern System of Tanning.—Preparation of the Ooze. The Leaches.—The Handlers.—The Layers.—Mixed Tannages.—Tanning by Suspension.—The Suspenders.—Scouring.—Drying the Tanned Butts.—Old American Method.—The Drying Loft.—American Turret Drier.—Working of the Turret Drier.—Influence of Light upon Leather.—Striking.—Rolling the Leather.—To determine when Leather is Tanned throughout.

Bark Tanning.—While being probably the oldest material used for converting hides into leather, oak-bark although hemmed in by a host of competitors, still retains its reputation as the best known source of tannin for the preparation of sole leather. It is not on account of its richness in tannic acid, for there are many vegetable substances which yield a far greater percentage of tannin than oak bark, but doubtless its great advantages—which are most fully developed in the layers—depend upon the way in which it is employed. When ground oak-bark is stratified between layers of skin deprived of its cuticle, hair, and flesh, the whole being saturated with an infusion of the bark, not only is the tannin *gradually* presented to the surfaces of the skins, or pelts, and the strength of the liquor maintained by the ground bark until it is exhausted, but the *feeding of the leather with vegetable extractive*—which is a slow and occult process—takes place, whereby the leather is materially increased in weight and solidity.

After the hides have been subjected to all the preliminary operations of *soaking, liming, unhairing* and *fleshing, rounding* and *raising*, the butts are ready for the tanning

process; and since this is conducted upon various systems, it will be necessary to treat of them separately, commencing with the older methods, which, so far as regards the excellence of the results obtained, have not been surpassed, even though a host of gifted observers have endeavoured to hasten the process without injury to the quality of the product. It must be understood that by the process of *raising*, the pores of the skin become distended or swollen, by which it more readily absorbs the tanning principle and its associate, vegetable extractive. In this condition the butts are ready for the *suspenders* or *handlers*, a series of pits in which the pelts receive their first dose of tannin from *weak* infusions of bark.

Old Methods of Tanning.—By one of the older methods of tanning, the hides were limed in very weak lime liquors, and the skins were brought to a condition for unhairing and fleshing in about three months. They were then placed between layers of coarsely-ground oak-bark in the pits, the layers of hide and bark being alternately formed until the pits were full, when a final stratum of bark was placed over the whole; no water or other liquor was allowed to enter the pits. After a few weeks the hides were transferred to another pit with interposed layers of fresh-ground bark, the top hide of the first pit being placed at the bottom of the next pit (which was previously strewn with ground bark) and so on until the position of the whole pack was reversed. After about three months the process was repeated, the spent bark being substituted for fresh bark each time. These changes were effected from time to time until the tanning was completed, which generally occupied about eighteen months, or even a still longer period.

An improvement in the above very slow method was afterwards adopted with great success. This consisted in filling the pits, after they had been filled up with alternate layers of hide and ground bark, with soft water; and when the tannin was found to be exhausted from the liquor or *ooze* thus formed, the pits were emptied and

again filled with hides and fresh bark, and filled up with water as before, these operations being repeated many times during a period of about fifteen months, at the end of which time leather of most excellent quality was produced.

By another method, a layer of spent bark, about six inches thick, was first spread over the bottom of the pit, and over this about an inch layer of fresh finely-powdered bark was placed, and upon this a hide was spread perfectly flat; another layer of fresh bark was spread over the hide, then another hide laid above this, followed by another layer of bark, and so on until the pit was full; the whole pile was then covered with a six-inch layer of bark, termed a *hat*. This being done, the whole was well trodden down and sometimes stout planks or boards, heavily weighted, were placed on the upper surface. The pit was then filled up with a weak infusion of bark, or ooze, and allowed to remain for two or three months, when the pit was emptied and the hides were stretched and again placed in the pit with alternate layers of fresh bark, and the pit again filled up with ooze as before. After three or four months the process was repeated several times, and at the last operation the pit was filled with *strong ooze*. In about fifteen months the leather was perfect.

Sometimes it was the practice, under the older systems, instead of filling the pits with water or ooze, to put a little water into the bottom of the pit, the vapour from which, rising upward, promoted the absorption of tannin by the skins.

Modern System of Tanning.—The practice, under the modern system of tanning, is to employ an infusion of bark or other tanning material, instead of water, in all stages of the process, and ooze of greater strength is used than in the older methods, whereby considerable time is saved in the conversion of skin into leather. The ooze is employed at various degrees of strength, progressively, the strongest ooze being reserved for the last operation. The tanning strength of the ooze is determined by an instrument called the *barkometer*, which is described in another chapter.

In speaking of the modern system of tanning, as distinguished from the older methods, we do not wish it to be understood that an uniform system of tanning is adopted by all manufacturers; indeed this is so far from being the case that it might be more correct to say that each manufacturer adopts a method more or less modified by his own experience and the discoveries and improvements of inventors which have from time to time been made known to him. And while some manufacturers, in every practical art, are more desirous of seeking and adopting useful improvements than others, it will naturally follow that considerable progress may be made in some establishments whilst others continue to work in "the same old groove" until successful competition renders a change inevitable. Again, the tanner's is a very "close" trade, and is conducted with an amount of secrecy that almost bars improvement, while it certainly checks the progress of the art in *this* country. Jackson Schultz says, with much truth, "When the English tanner shall become as communicative as he is at present reticent, the whole world will be enlightened as to the economy of these agents, with those in use with tanners of the rest of the world." This, however, we can scarcely expect while our American competitors, in the language of Mr. Schultz, "shoot at us from behind a hedge of more than 30 per cent. import duty."

The process of tanning, as generally conducted at the present day, we will now describe, but we recommend that fair attention should be paid to some of the numerous mechanical contrivances described in subsequent chapters which have for their object the uniform diffusion of the tannin throughout the whole of the pack or series of hides in the earlier stages of the operation, as also those mechanical devices which have been designed to economise the labour of *handling*.

Preparation of the Ooze. The Leaches.—This is conducted in vats or pits termed *taps* or *leaches*.* These pits

* Also called *leiches* or *latches*.

are usually about 9 feet square and 5 feet deep, each one being capable of holding sufficient liquor for two *handlers*, or pits in which the pelts are first treated with tan liquor. The leaches are commonly fitted with a false bottom, so that the liquor may be pumped or drawn off the spent bark as required. The ooze is prepared by placing a quantity of ground oak-bark in the pit, to which cold water is added, and the liquor formed filters through the false bottom, fresh water being introduced from time to time until the bark is exhausted of its tannin. Some tanners prepare their "liquors" or ooze with hot or lukewarm water, by passing steam through a large iron pipe to the lower part of a deep pit containing a mixture of the bark and water. A little above the true bottom is a false bottom, through which the liquor filters into the space below, and from which it is withdrawn by suitable pumps. Steam pumps are now generally employed for this purpose, as also for transferring the liquors from one pit to another; some of these pumps are capable of distributing as much as 13,000 gallons of liquor per hour. By another system, water is first applied to nearly exhausted bark, which is allowed to remain at a moderate heat for a considerable time, and the weak infusion thus obtained is pumped into a pit containing bark somewhat less exhausted. The liquor from this second pit is then transferred to a third still richer in tannin, and so on through a series of leaches until it reaches a leach or pit containing freshly-ground bark, from which pit the liquor is withdrawn for use. The liquors or oozes are termed respectively *handler liquor* and *layer liquor*, the latter being the stronger.

The Handlers.—When the butts have passed through all the preliminary processes, they are transferred to the *handlers*, a series of pits 7 feet by 5 feet, and 5 feet deep, in which they are treated with weak infusions of bark, commencing at about 15° to 20° by the barkometer, being handled twice a day during the first two or three days, either by turning them over in the liquor, or by taking them out one by one and piling them in a heap, and

then replacing them in reverse order in the pit. The operation of handling is shown in Fig. 15. It is more generally the practice, however, to work the handlers in what is termed *a round*, which may consist of six pits. In the first of the series the washed butts, as they come from the beam-house, are placed; or, when *suspenders* are employed (to which we shall presently

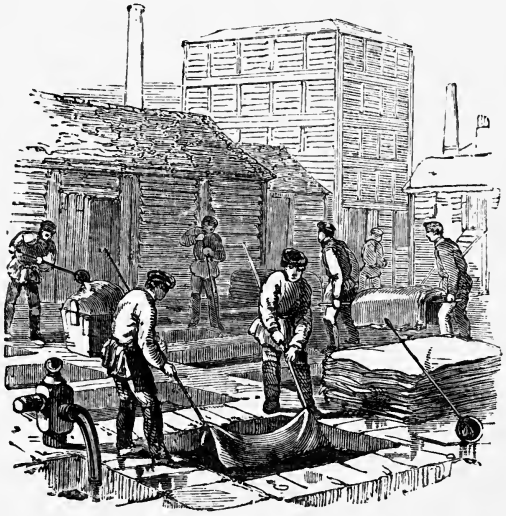

Fig. 15.

refer), those which have received a preliminary treatment in these vats. The butts are placed in the first pit, one by one, and are handled once or twice a day, by removing them from and returning them to the same pit, after which they are shifted to the next, and so on, through the first four pits; after which they are treated in the last two pits of the series in this way: the butts are spread out one by one in the next pit, each butt being sprinkled over with a thin layer of finely-ground oak-bark, which has the effect of keeping them from absolute contact,

whereby the ooze more readily reaches all surfaces of the butts, and at the same time augments the strength of the liquor; moreover, by this system the *feeding* of the skin with tannin and extractive matter is greatly augmented. After being thus treated, they are allowed to remain for about two days, when they are removed, to allow the introduction of fresh liquor and powdered oak-bark, to which treatment they are subjected about three times a week. The other packs follow in due succession, and eventually the first becomes the most advanced, while the last pack, fresh from the beam-house, becomes the first of the next round, and so on.

When all the pits have been worked in this way, the last pit eventually contains merely the stale sour liquor through which all the butts in the round have successively passed. This liquor is generally pumped into the "suspenders," where such are employed, in which any tannin that may still be present becomes absorbed by green or fresh butts, after which the liquor, being exhausted of its tannin, is run off as waste. As each pit becomes empty, it is cleaned out and recharged with fresh clear liquor or ooze from the leaches, the strength of which varies from 20° to 30°, according to the practice of the tanner.

The treatment of butts in the handlers generally occupies about six or eight weeks, by which time the colouring matter of the bark and the tannin should have *struck*, as it is termed, through about one-third of the substance of the pelt. By this time the butts of the oldest packs will generally have become covered with a peculiar *bloom*, as it is called, and which is *ellagic acid*, a substance insoluble in water; the substance of the pelt is also materially increased in weight, and is more firm and solid. In this condition the butts are next removed to the *layers*, in which they receive the final treatment of bark and ooze, in progressive stages, until the tanning is complete.

The Layers.—In these pits, which are termed *lay-aways* by the Americans, the butts are stratified with

ground oak-bark, which is carefully spread between each butt to the depth of about one inch. A layer of bark is first spread over the bottom of the pit, and a butt is then laid over this, followed by another layer of bark, then a butt, and so on until the pit is full, a layer of ground bark, called a *hat*, being placed on the top. The pit is then filled up with ooze at about 30° to 35°, more or less, according to the practice of the tanner. The layer is then allowed to rest undisturbed for five or six weeks, by which time the tannin, with extractive matter, will have combined with the animal fibre. The butts are then taken out, and the spent bark and ooze removed, after which they are stratified with bark as before, and the pit then filled, being in this second layer treated with ooze at about 40°. At the end of about three months, the butts are again shifted, stratified with fresh bark, and treated with a still stronger ooze. About the end of six months from the commencement, the thinner butts will have become perfectly tanned, while the stouter butts will require to be treated again with fresh bark as before, with ooze at about 60°, or even higher, and in this layer they must remain for about six weeks or two months. Mr. Schultz strongly objects to the practice of working butts of irregular thickness in the same pack, and indeed common sense would support his view, since it is obvious that while the stouter butts would be imperfectly tanned, some of the thinner butts, being tanned, would probably suffer from prolonged immersion in exhausted liquor.

In shifting the butts from one pit to another, the top butt of one pack becomes the bottom butt of the next, by which change of position the action of the tannin and the effects of pressure become to some extent equalised throughout the entire pack. There appears to be no fixed rule as to the strength of ooze, or the period of time which should be allowed for tanning heavy butts, since each tanner adopts a method of his own; indeed, in this as in every other branch of the art, there appears to be considerable difference in practice—personal judgment rather than fixed rule being the chief guide in most of the

operations of the tanner. A general view of the tan-pits is given in the engraving Fig. 16.

Mixed Tannages.—As to the materials employed in butt tanning, there is considerable difference in practice at the various tanneries. While some tanners prepare their liquors entirely from oak-bark, others use valonia for their liquors, and employ ground bark only for sprinkling, or "dusting" in the handlers; other tanners employ two-thirds valonia to one-third myrobalans in making their liquors, or one-half valonia to one-fourth each mimosa and myrobalans. Divi divi is not extensively used in butt tanning owing to its liability to induce fermentation; but since it is a cheap material and is reputed to give good weight to the butt, there is a natural desire to employ it as far as can be done with safety, with or without the use of *antiferments*. In some tanneries, divi divi is used in small proportions with each tap or leach, by placing it beneath the other tanning materials, so as to keep it as far as possible from the air. If, however, its susceptibility to fermentation is due to mucilaginous or other vegetable matter (which is most probable), its exclusion from the air would not, we should think, be of much consequence; but its tendency to promote this decomposition might be more readily checked by employing one or other of the substances which have been found most effective in arresting gallic fermentation.

Valonia is an important tanning material, but when used alone it imparts an objectionable colour and harshness to the leather; it is therefore most generally employed with a moderate proportion of myrobalans. An excess of the latter would be mischievous, since they are considered liable to promote gallic fermentation. Mimosa is much used to modify the colour of valonia, since it imparts an agreeable pinkish tinge to the leather which is generally approved. Being a powerfully astringent substance, while yielding a strong colour, it can only be used in moderate proportions. The tannin of this material requires to be extracted by boiling water—steam heat being generally employed—and the liquors are usually prepared in separate pits.

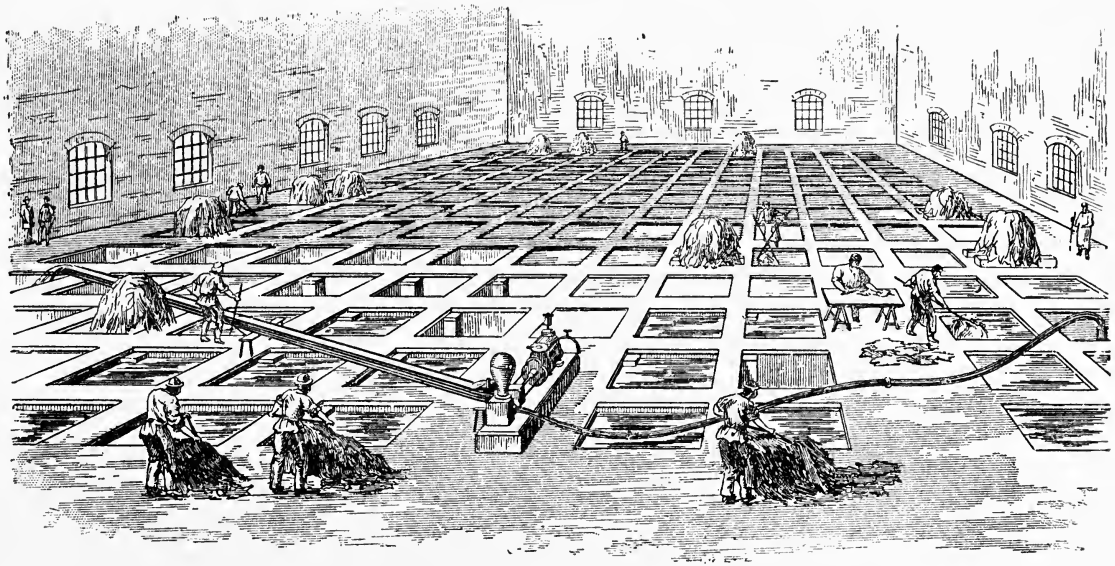

Fig. 16.

Mimosa liquors are not so susceptible of gallic fermentation as the tannins obtained from some other materials, as divi-divi, for example. Gambier, or terra japonica, is frequently added to the handler liquors in moderate proportions, and is specially useful in keeping up the tanning strength of the liquors. Of the many new tanning extracts which are now largely imported into this country, oak-wood, chestnut, hemlock, and mangrove are prominent, and the two former have now firmly established themselves into favour; but it will probably be a very long time before any English tanner will use—from choice—any tanning material but oak-bark for the preparation of the best quality of sole leather. Indeed, while the *tan colour* of oak-bark remains the accepted colour of the best English leather, it will be difficult to induce the trade to recognise any leather, as of the best oak-bark tannage, which presents a different tint to that to which they have been so long accustomed.

Tanning by Suspension.—In some tanneries it is the practice to suspend the hides in weak tanning infusions before they are treated in the handlers. The object of this system is to ensure the uniform absorption of tannin by the pelts before subjecting them to the rough usage of handling, which in the early stages of the process is liable to cause injury to the delicate structure of the pelt. It will be readily understood that after the pelt has become partially tanned it is less susceptible of injury, and any method, therefore, which will effect this object without subjecting the delicate texture of the unhaired skin to the chances of abrasion, or to the rough treatment of iron hooks, must be advantageous. When the hides have become partially tanned, they are more capable of bearing without injury the rougher treatment which handling, however carefully conducted, necessarily involves.

The Suspenders.—There have been many ingenious contrivances introduced for suspending hides in the tan liquors, both in the earlier stages of the process and also for the complete tanning of hides, the latter of which will be described hereafter. In one form of suspender

a stout wooden shaft is placed across the pit lengthwise, being partially immersed in the liquor; to this shaft about 20 hides are attached, one above another. When the shaft revolves, the first or upper hide becomes lowered into the liquor, followed by the second and third, and so on, the entire pile of hides becoming unfolded as it were, and one by one lowered into the liquor; as the shaft continues to revolve, the hides become alternately exposed to the air and the tan liquor. Doubtless it would be an improvement if the hides could be kept *under* the liquor the whole time; still the exposure to the air is only momentary, and certainly much less than in the ordinary system of handling. By this method the butts would undoubtedly be constantly exposed to fresh surfaces of tan liquor—a most important point to be reached in all processes of immersion in which chemical action plays a part.

The American Rocker Handler, described in another chapter, is much adopted in the United States, and is, we believe, used to some extent in this country. But although in the early stages of tanning, when the object is to impregnate the skins throughout with a moderate amount of tannin, the practice of keeping the hides in motion while in the weak* liquors is doubtless advantageous, in the latter stages the reverse treatment appears to be accepted as that which is most favourable to the proper *feeding* of the hide and the production of good leather. This fact was established by the older tanners and recognised by Sir Humphry Davy and all observers of eminence who had studied the subject. In support of this, Jackson Schultz says, "Leather tanned while at rest will have a firmer texture than if motion is used to aid the tanning. This would probably be the testimony of the butt tanners of Great Britain, and there is much in our own experience to confirm such a view of the case." Indeed, when we reflect that not only tannin but vegetable extractive enters

* If the pelts were immersed in strong ooze at first, they would become *case-hardened*, as it is termed, in which state they would offer great resistance to the further absorption of tannin.

into the composition of sound leather, it will at once be apparent that this substance—not having the same affinity for gelatine as tannin—would necessarily require a condition of rest to enable it to combine, even in small quantity, with materials which have so powerful an affinity for each other. To *feed* the leather properly, therefore, *rest* during a greater portion of the time required for tanning is an absolute necessity in the preparation of what is known as *leather*—that is, not merely a spongy compound of tanno-gelatine *plus* colouring matter, which frequently passes under that name, but leather properly so-called.

After the butts are removed from the layers, it is sometimes the practice to throw them into pits containing weak tan liquor, and then to take them out one by one, and brush them all over to remove particles of spent tan which may have adhered to them; they are then laid across a beam called the *horse* to drain. It is usual at this stage—especially with butts of the best bark tannage—to *strike* them with the pin (Fig. 18) while still moist, to remove the *bloom;* but sometimes this is effected by laying the butt flat on the scouring-table and rubbing it with a stone called the *scouring-stone,* a tool provided with two sharp edges produced by working on a grindstone. With this tool the workman removes every trace of bloom from the grain side of the leather. The grain side is next rubbed over with a damp cloth, then with a dry one, and afterwards linseed oil is rubbed over the grain to prevent the too rapid drying of this surface of the leather.

Scouring.—This is sometimes effected by *scouring-machines,* one of which, the "Burdon" scourer, is shown in Fig. 17. See also Fig. 66, p. 408. After scouring it is sometimes the practice to strike the leather with the pin to *lay the grain,* and after this the grain side is oiled, and the butts then sent to the loft, where they are hung up and allowed to remain until partially dried; they are then taken down, the flesh and grain sides slightly damped, and the butts are next piled in a heap to *sam,* or

samm, as it is termed, for several days, by which the leather becomes *tempered*, or in an uniformly moist and

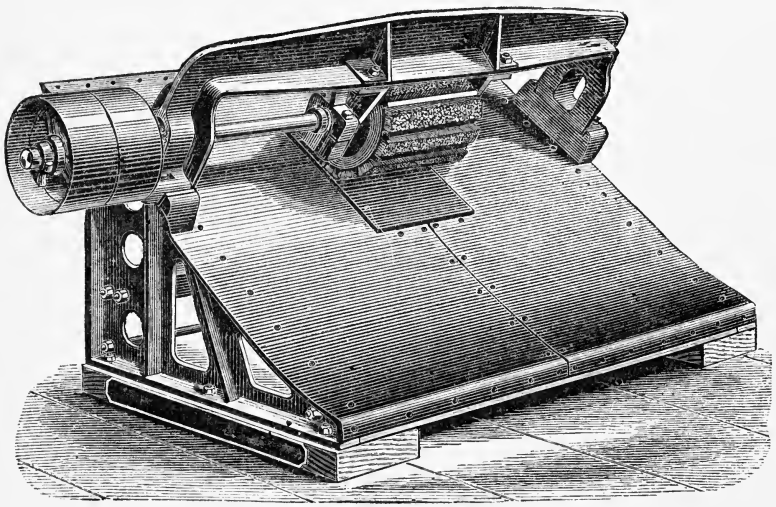

Fig. 17.

softened condition. In this state it is ready for the first *rolling* operation, which will be described further on.

Drying the Tanned Butts.—Although apparently a simple process in itself, much skill and judgment on the part of the workman are required to dry recently tanned skins properly. If the drying be too slow, especially in damp weather, the leather is apt to *mould*, which is very injurious to it; if, on the other hand, the drying be too quick, or the leather is exposed to the direct rays of the sun, it is liable to become discoloured, hard, and brittle. A well-ventilated loft, in which the skins may be exposed to a gentle but continuous current of air, without being subject to the direct solar rays, is considered most favourable for uniform and perfect drying.

Old American Method.—The skins, when sufficiently tanned, are taken from the pits without being shaken or

beaten, and are stretched on pegs or hung up by their heads from large nails, each one being kept expanded by two or three sticks passed through from side to side, so that all parts may be uniformly exposed to the air. When they have begun to whiten, and have become slightly stiff, but before they are perfectly dry, they are stretched out upon a clean place and scoured with the spent tan with which they are still covered. When well cleaned in this way, they are then to be trodden out and beaten with the soles of the feet in every direction upon both sides; and after the inequalities and protuberances of surface have been made to disappear by the flattening process, they are assorted in sizes and piled up in heaps. While the skins are stretched in the drying-room they should be beaten twice daily, morning and evening, upon the flesh side with a round-faced wooden mallet. If the skins should be dry, the operation may be facilitated by moistening their surface with a wet brush. This process imparts firmness, but the operations are now almost entirely done by machinery.

The Drying Loft, or **Shed,** as it is sometimes called, is a capacious wooden structure, one or more stories high, according to the extent of the works. It is provided with a series of openings all round the apartment, through which the wind from any quarter can pass freely, and thus traverse through the suspended hides. These openings are protected by weather-boards, or trap doors, which can be placed at such an angle that while the air may be admitted as required, the direct rays of the sun can be prevented from reaching the leather. The circulation of air is further aided by a portion of the flooring being composed of narrow boards placed at a certain distance (about 2 inches) apart from each other, whereby air is admitted from below as well as at the sides and ends of the shed. To facilitate the drying, especially in cold and damp weather, a series of 4-inch flanged iron pipes, for steam or hot air, are fixed above the floor, this range of piping extending all round the interior of the shed. These pipes are frequently heated by waste steam from the boiler. Although

this system of artificial drying is by some persons believed to be injurious to the leather, on the ground that the heat *dries the air*, it must be borne in mind that the moisture given off even from merely *damp* hides would be amply sufficient to compensate for the natural moisture expelled by the heat from the steam-pipes. When the drying of the hides is near completion, however, greater caution would undoubtedly be necessary in subjecting them to the continued action of hot-air pipes.

The *hygroscopic condition* of the air—that is, the presence or absence of moisture—may be determined by means of an instrument called the *hygrometer*, of which there are several different forms. "Mason's hygrometer shows the relative dryness and moisture of the atmosphere by the degree of cold produced by evaporation from a given surface. If two delicate thermometers have their bulbs covered with a thin piece of muslin, and if the one be dry and the other moist, the depression of the latter will be directly as the rapidity or amount of evaporation, and this again will chiefly depend upon the state of the circumambient air as to moisture; if it be charged with vapour, no evaporation from the wet bulb will ensue, and consequently the mercury in that thermometer will remain stationary; if, on the contrary, the air be very dry, it will eagerly abstract vapour from the humid surface, and a corresponding degree of cold will be indicated by the depression of the mercury in the humid thermometer as compared with the standard or dry thermometer."—*Brande.*

To roughly determine whether the drying of the leather is complete in an apartment heated by steam or hot-air pipes, a small pocket looking-glass, previously kept in a *very cold* situation, might be used. If the glass be held about half an inch from, or nearly touching, the suspended leather, if moisture be still given off from its surface this will be at once *condensed* on the face of the glass, as if it had been breathed upon; if the reverse is the case (provided that the glass be *cold*) it may be concluded that the leather is perfectly dry.

In some tanneries the drying sheds have been heated by hot-water apparatus in place of steam, and we believe with success.

About 6 feet above the floor of the drying-loft a series of rafters are fixed, and upon these are laid the wooden poles, called "shed poles," from which the hides are suspended. These poles are simply timber from which the bark has been removed; they average about $2\frac{1}{2}$ inches in thickness, and are from 6 to 8 feet in length.

American Turret Drier.—A brief description of the American "turret drier" will prove interesting to those who may be desirous of modifying their present method of drying, or may require an extension of their present drying arrangements. The following is abridged from Mr. Jackson Schultz's admirable description of the turret drier: The building may be any number of stories high, some being three or four, while others are seven or eight. Mr. Schultz, however, recommends but five stories, each about 7 feet clear between the beams, or high enough for a man to pass with his hat on. Such a building need not be made of very heavy timber, and therefore would be inexpensive as compared with higher structures. The building should be about two spans of timber—say 40 feet—wide, with two rows of posts equidistant from the sides. Longitudinally with these rows of posts should run a light board partition, with intersections at every 10 feet, extending to the sides. This would cut the space up into two rows of rooms about 10 by 12 feet each, with a centre passage of about 13 feet. The roof is made of the usual latticed lantern form from end to end. All the floors above the ground-floor should be latticed, and the rooms would of course be immediately above each other, so that if the building were five stories high, there would be five rooms, 10 by 12 each, standing one above another, and there should be just as many of these rooms as would dry the stock of the yard. The centre passage-ways should be lighted by cross-sections leading to the windows, and each room should contain one small window close to the top to admit light only. There should be no openings

except at the base of the lower room, with the air leading directly on the piping.

Each room will hold one pack of 100 or 120 hides, depending upon the weight of leather, and will dry the same in ten days. The rooms on the first floor should be supplied with steam-pipes laid on the floor, or raised only a few inches above it. The heating of the pipes should be under separate control, so that any degree of heat can be admitted, and the steam turned on or off at pleasure.

Working of the Turret Drier.—All the packs taken out in one day, or in two or more days in succession, should go into one of these sections, so that the condition of the leather may be as nearly uniform as possible in each set of rooms. The leather is hung upon sticks, in double rows, leaving a passage of nearly two feet between. No steam should be allowed to enter the pipes or the section during the first three or four days, neither should the trap-doors, which lead outwardly, be opened but slightly except in warm weather, or when the wind blows high; but in autumn, or during overcast weather, the lower trap-doors may be safely left open. About the third or fourth day a low degree of steam heat may be applied, and gradually increased until the seventh to the tenth day, by which time the leather should be fully dried. All the hides in both tiers and in all the five rooms will have dried in about the same time, and may be replaced by others. Mr. Schultz says, "One of the best guides that I can give for the capacity and practical working of these driers in connection with a tannery is this: one of these sections should be large enough to hold one-tenth of ten days' work. I have known turrets so actively worked as to turn out stock in seven days; but I prefer ten, since it is very important not to hurry the drying during the first few days. . . . . The turret drier is, beyond all question, the most efficient and artistic method yet devised for drying leather, and, in some of its modified forms, should be adopted by all tanners. The difference in the temperature at the ground and at an altitude of 40 or 50 feet

would of itself create a draught, as is well illustrated by the erection of stacks or chimneys for the passing off of smoke or gas. But, if to this natural action of the difference of temperature we add a little steam heat, a steady yet moderate circulation will be maintained from the bottom toward the top or opening of this structure, carrying upward and off the dampness from the leather, without creating such violent currents of air as to stain and injure the colour."

Mr. Schultz says that it is believed that the principle of the above method of drying sole leather could be applied with equal advantage to all other kinds of leather; and indeed, when we consider that the gentle motion of the heated air—constantly ascending as it does from the steam-pipes—must keep up a continued circulation of the air within the drying-rooms, this should be the most favourable condition under which even the most delicate leathers could be dried, provided that the temperature were kept as low as possible to effect the object.

For the purpose of conveying the hides to and from the drying-rooms, lifts or elevators are employed, which may be of any approved construction; but Mr. Schultz speaks very highly of an endless chain elevator which he strongly recommends to all tanners. This consists of an endless chain, running from the extreme bottom to the top floor, ending under the roof. The chain runs in a wooden box enclosed on three sides. The open or outer side serves to attach the hides by means of hooks fixed to the links of the chain at a distance of about 4 feet. The distance between the attaching hooks should be sufficient to enable the workmen to attach below, and take off above, the sides. By this simple method leather may be elevated with no more actual expense than if dried on the ground-floor, and the hides, when once hung, remain until fully dried, thus saving all the expense of "shifting," &c.

Influence of Light upon Leather.—The influence of light upon the colouring matter and juices of vegetable substances is well known; and while this is not so marked

when such matter is diffused through the cellular structure of the plants—by which it is protected from the action of light in some degree—if the vegetable substance be cut or otherwise injured, a discoloration or darkening of the part takes place rapidly afterwards. This is very noticeable when we remove the epidermis or bark from a growing plant; the exposed surfaces soon assume a darkish colour, which increases in depth by further exposure. Probably absorption of oxygen may also influence the result. The fact is specially recognisable in the case of the walnut, the green covering of which is well known to impart a deep brown stain to the fingers. The same may also be said of young potatoes, in removing the skin from which the domestic servant frequently finds the tips of her fingers embellished by a brown stain. Now in the preparation of oozes, or infusions of bark, the ground material, fresh from the mill, is steeped in water—either warm or cold—and while the tannin most readily enters into solution, vegetable extractive and colouring matter also become dissolved in the menstruum. Now, what we wish to suggest as the *cause* of the newly tanned leather becoming darkened by exposure to air and strong light is this: that the vegetable tissue in which the greatest amount of astringent property lies (the part which was nearest the wood) also contains *colourable* matter which has not yet been fully exposed to the action of strong light, and that an infusion of this matter must, in the ordinary course of things, become darkened by exposure to light. And further, that when hides are steeped for a more or less lengthened period in such infusion, the leather produced must be acted upon and become discoloured, or darkened in colour, by exposure to light, more especially while in a moist condition.

Schultz says, "Leather dried in the open air will certainly dry dark, even if tanned with pure oak, and if tanned with hemlock, or a mixed bark, will darken to a damaging extent. If currents of air reach the leather while in a wet state, a like result is produced, with the addition of great harshness of grain. If a bright light,

particularly if the sun's rays reach the grain or flesh, the acid of the leather turns brown, and is permanently discoloured. The influence of the direct rays of the sun, or even the strong light of the sun, on vegetation is a good illustration of these influences on the colour of leather containing vegetable acid in solution. The ordinary table celery is covered with earth as fast as it grows to the surface to keep the light from it, so that it may be white and *tender*. Grass that grows under cover, excluded from light, is white, not green. This law of light applies to all vegetation. Availing ourselves of this principle of light, we say that leather that is intended to be fair should be dried in the dark, and as free as possible from currents of air."

Although, as we have said, we believe that light has a powerful influence upon the vegetable matter absorbed by the hide, we believe that the oxygen of the air also plays an important part in this discoloration, or rather *coloration*, since from the examples we have given, light alone could scarcely have produced the effect. The scratched rind of the green walnut produces an almost instantaneous stain, which may be partially, if not wholly, due to oxidation; while the celery referred to by Mr. Schultz would doubtless (if not protected by earthing up) acquire its natural green colour by the action of light only.

Striking.—When the hides are partially dried, as we have before observed, they are submitted to the operation

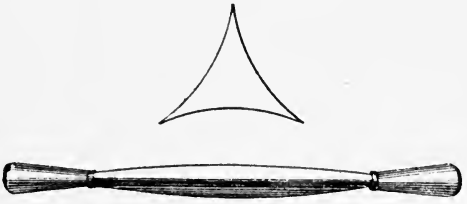

Fig. 18.

known as *striking*, which is accomplished with the *striking-pin* (Fig. 18) a two-handled tool of triangular form present-

ing three blunt edges. A section of the blade of the tool is also shown. The butt is thrown across a horizontal convex beam, called the *horse*, and the workman, taking the tool by its handles, presses it firmly over the grain side of the leather, until the entire surface has been gone over. Fig. 19 represents a workman in the act of *striking* a butt. To economise labour in this operation several forms of strik-

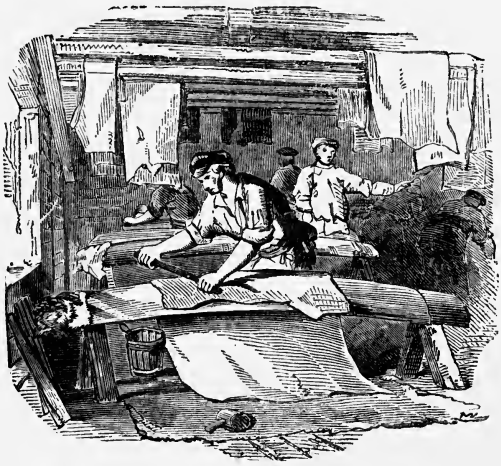

Fig. 19.

ing-machines, worked by steam, have been introduced. The accompanying drawing (Fig. 20) represents the striking-machine of Messrs. Huxham and Browns, and Fig. 66 that of Messrs. Wilson, the latter being generally used in British yards for butts and bends. It is stated that leather struck in these machines acquires a solidity and firmness superior to that of hand work, while it also enables the tanner to do with less rolling. The workman, by a weighted adjustable foot lever, regulates the pressure instantaneously, so that no part of the leather remains untouched. Although hand striking is still much applied, there can be little doubt that in this, as in many other operations of the tanner, machinery, from the rapidity

of its action, will eventually supersede hand labour to a great extent.

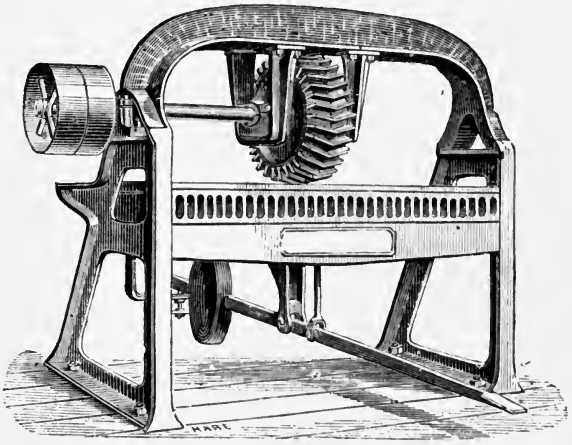

Fig. 20.

Rolling the Leather.—When the butts are partially dried, they are submitted to the first operation of rolling. For this purpose hand or steam rollers are used. The hand machine consists of a brass cylinder or roller, surmounted by a heavily weighted box-truck, and furnished with a long handle. The butt is laid flat upon a solid and level wooden bed coated with metal (zinc or brass being generally used), and the workman passes the roller backwards and forwards until every part of the butt has been repeatedly passed over. Fig. 21 shows the method of using the hand roller. After the first rolling, the butt is again hung up to become further dried, when the oiling and rolling are repeated, and if necessary, the two surfaces of the butt are moderately damped each time before repeating the rolling. There are many ingenious and effective machines for steam rolling, which, as will be readily understood, effect a great saving in labour, besides being more uniform in their action than could be expected

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from the smaller or hand machine. In Fig. 22 is shown a rolling-machine as supplied by Huxham and Browns.

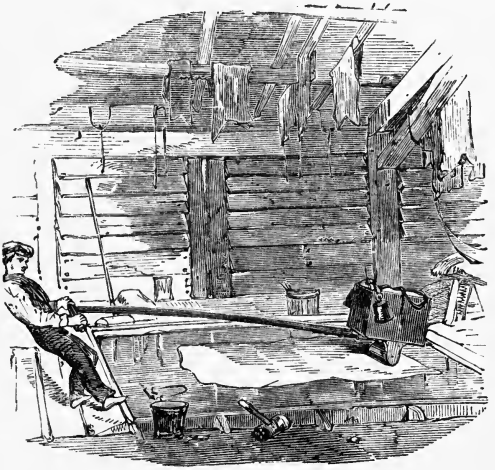

Fig. 21.

The roller is hung upon strong springs, which allows it to adjust itself to inequalities in the thickness of the

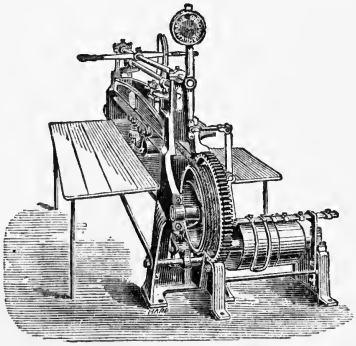

Fig. 22.

leather. When in use, the leather is laid flat on an ordinary zinc or brass bed, as in hand rolling, and the

roller passed over it, so as to avoid the stretching and cockling of the leather which it is said some machines are liable to cause. Fig. 23 represents the American Pendulum Roller. It is said to be especially suitable for leather requiring heavy rolling, such as buffalo, kip hides, &c. Speaking of this machine, Schultz says that it is claimed that if used at its full pressure the machine has a sufficient power to actually cut the leather in half. It is,

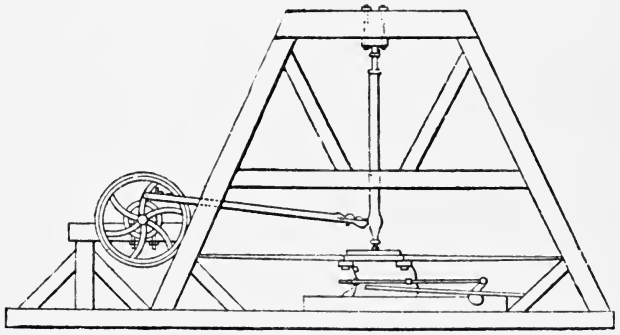

Fig. 23.

however, fitted with adjustable spring bearings, enabling the roll to adjust itself to unequal thicknesses in the leather, and the pressure may be regulated at will.

To determine when Leather is Tanned throughout.—This is ascertained by making a clean cut with a sharp knife in the stoutest part of a butt, when, if the tanning is complete, the leather exhibits an uniform colour throughout its entire substance; if, on the contrary, a light-coloured streak is visible in the interior, the process is not complete, and the butts must be submitted to further treatment in the layers until the proper point is reached—a perfectly uniform colour throughout the entire substance of the skin. Beyond this point, however, the further steeping of the butts can do no good, and may therefore possibly do mischief in proportion to the length of what may be termed unnecessary time they may be

immersed in the tan liquor. The aim of many tanners appears to be to ensure a good *bloom* upon their leather—as a guarantee, we presume, that it has been *bark-tanned* by a gradual and not by a quick process; but when the perfect and complete tanning is effected, protracted immersion in the pits, merely to increase the deposit of ellagic acid or bloom, to give an appearance to the leather which cannot enhance its durability, would appear a mistaken practice, and one which the American tanners —who are making great progress in the art—seem to ignore.

CHAPTER XIII.

TANNING PROCESSES.

The first English Patents for Tanning.—Newton's Tanning Process.—Aldrich's Process.—Orgereau's Process.—Jennings's Process.—Ballatschano and Trenk's Process.—Lomas's Process.—Michel, Kollen, and Hertzog's Process.—Keasley's Process.

As in the case of every other art, innumerable patents have been obtained, both at home and abroad, for improvements in the processes of tanning, and for the machinery and implements employed therein, besides many others for inventions more or less connected with the manufacture of leather. It is of the greatest importance to those who pursue an art or manufacture that they be acquainted with such modifications of the ordinary methods of working as may be likely to render their procedure more facile or more economical, or otherwise tend to render their manufacture more perfect in its results. With this view we have selected from the lengthy roll of patented inventions certain processes which we hope may prove in some degree interesting and useful. While refraining from making any comments upon the merits of any of these processes, we may indulge a hope that from some of them at least may be gleaned a fair amount of useful information.

The First English Patents for Tanning.—As specimens of the orthography of the seventeenth century, the following quaint titles of specifications may prove interesting. The first patent for improvement in leather was

obtained by John Jasper Wolfen, and is dated December 8th, 1627. It runs as follows:—

"A newe invencon for the making and ꝑparing of ctaine stuffs and skynns to hould out wett and rayne."

In 1635 Christopher Hunt obtained a patent for a "Newe invention by way of 'ymbrodering or hufling of guilded leather upon several grounds fitt for hangings or other furniture for houses.'"

In 1660, Charles Howard patented "A newe way for the tanning, tawing, dressing, and ꝑparinge all sorts of rawe hydes and skinnes into leather in lesse time and with lesse charge then formerly hath bin vsed."

Newton's Tanning Process.—The object of this process is to hasten the operation of tanning by employing certain earthy or metallic salts in combination with vegetable astringent matter, by the joint action of which it is said the combination of the albuminous matter of the skin with the bases is promoted. When other matter than catechu is used, the latter, of good quality and containing 50 per cent. of tannin, is taken as a standard for regulating the proportion of the former. The skins must as usual be unhaired and free from lime. For treating 100 calf-skins the following formula is given:—

Alum	20 lbs.
Salt	10 „
Catechu	100 „
Sulphate of alumina	4 „

The latter salt may be used either alone or mixed with 2 lbs. of common salt. The three mixtures are dissolved in water in separate vessels, and kept apart. The following directions are given for applying the various solutions: put into a vat one-fifth of the first solution, one-tenth of the second, and one-fourth of the third; immerse the skins in this liquor, handle and stir them repeatedly for a short time, then take them out. Now refresh the vat by the addition of one-fifth of the first solution, one-tenth of the second, and one-fourth of the third. Replace the skins in this mixture; treat as before, but for a longer

time. Remove the skins a second time, refresh the vat with one-fifth of the first solution, one-tenth of the second, replace the skins in the vat, and allow them to remain for some time, handling occasionally as before; remove them again, and mix in the vat the residue of the first and third solutions, and one-fifth of the second. Replace the skins in the vat, and a few days after take them out and add to the vat the remaining two-fifths of the second mixture. Four or five weeks are sufficient to complete the tanning.

The above process may be modified by laying the skins in a vat and stratifying them with 3 lbs. of moistened tan. Other skins can be thus tanned, but the proportions must be varied, as shown below:—

For 100 goat skins, take—

Alum	10 to 12 lbs.
Catechu	50 to 60 „
Salt	6 „

For 100 cow hides, take—

Sulphate of alumina	40 to 50 lbs.
Salt	20 to 25 „
Catechu	500 „

For ox hides, per hide, take—

Sulphate of alumina	14 to 16 lbs.
Salt	8 „
Catechu	60 to 70 „

Aldrich's Process.—It is well known that when green hides have become dry the surface of the flesh side becomes hard or "flinty," and this condition is a source of much trouble to the tanner, and necessitates severe mechanical treatment to render the hides sufficiently soft to undergo the several processes which convert them into leather. Upon this subject Dussauce makes the following observations: "As a green hide becomes dry, by evaporation of its liquid, the flesh side absorbs oxygen from the atmosphere, which, combining with the fresh fibro-gelatinous surface, forms a hard flinty scale. To free the hide from

the scale, and facilitate its softening, tanners submit it to hard beam breaking, or to the action of a hide-mill, both of which have the detrimental effect, to some extent, of disturbing the uniform relations of the interposed gelatine, and loosening the small bundles of fibres composing the structure of the hide, thereby weakening the hide in its textile strength; nor have any of the modern soaks proved less detrimental, depending as they do upon a putrefactive condition (sweating). The first effect of such soak is to decompose the parts of the hides easiest effected, generally the fibro-gelatinous structure immediately beneath the scale; hence the frequent water peltings and running of hides in the soak, particularly in warm weather."

As a substitute for the ordinary mechanical treatment and soakings, which are thus so clearly shown by Dussauce to be mischievous to the structure of the hides, Mr. Aldrich, of St. Louis, U.S.A., devised a chemical process by which it is said the hides may be rendered as soft and pliant as when first removed from the animal.

Aldrich's process for the treatment of dry flint hides is thus given :—

The hides are first soaked in clear water until pliant; they are then placed in an acid bath composed as follows :—

Acetic acid	1 part.
Water	16 parts.

In from 24 to 36 hours the above solution will dissolve the scale, by combining with its oxygen, and swell the fibres of the hides, when they are to be immersed in the following bath :—

Carbonate of ammonia	1 part.
Water	70 parts.

This solution, having a strong affinity for the acid absorbed by the hide from the first bath, saturates it in from 48 to 72 hours, leaving the hide in a naturally pliant and soft condition, and so perfectly transformed from a dry to a green condition that no tanner can detect the slightest difference between stock tanned from dry hides so prepared

from the green hides. The first cost of the acid solution is two cents per gallon, or twenty dollars for a large pool full, after which it can be used continually, attended with no expense except pumping up and passing it through the apparatus to renew its strength after it has been used. The second solution is prepared from all bate water, and is attended with no expense but pumping.

The above process is said to obviate all danger of damage from taint or running, for its action is so perfectly antiseptic that hides so softened may be kept for weeks in water before being placed in lime; also by keeping fibrous and flanky hides in the first bath double the ordinary time, they will plump up and be materially improved, and all without any breaking whatever.

Orgereau's Process.—The object of this process is to shorten the time usually occupied by the tanning process, and which is effected by a systematic arrangement of the materials employed. The skins are submitted to the usual operations of depilation and raising, and are then placed, in alternate layers of tan and skin, in a vat with a perforated false bottom. This vat being about three-fourths full, is drenched with water for the first operation, and with weak tan liquor for the succeeding operations. The liquid slowly penetrates into the mass, and after having moistened the contents of the vat, runs through the false bottom into a reservoir, from which it is conveyed back to the surface of the materials. The inventor employs six vats, each containing 100 native or 120 imported hides. The liquid passing into the reservoir is daily distributed over the surface of the materials in the vat by means of a pump. This operation is continued for one month, at the end of which time the vat is emptied and the spent bark replaced by fresh bark, and the same process of infiltration repeated. A third operation is necessary to obtain a proper tanning. The entire process occupies four months, and the leather produced is stated to be equal in quality to that obtained by the old method; 100 parts of dry Buenos Ayres hides yield, by the above process, 150 parts of leather. It may be mentioned that

the inventor of the above process is an eminent Parisian tanner.

Jennings's Process.—In applying this process to thick ox hides, they are first unhaired in the usual manner, either by steeping them in a lime bath, or by the more recent process of *sweating*. If lime has been used, the hides are steeped in dilute hydrochloric acid after they have been dehaired, and then washed. This operation proves and fits them for the succeeding operations. They are now piled in batches of a dozen hides each, with a hurdle or wicker between each pair; they are then alternately lowered into tanks filled with the following solution :—

Tank No. 1 is charged with a strong solution of alum, to which 10 per cent. each of sulphuric and hydrochloric acids are added.

Tank No. 2 is charged with a concentrated solution of soda ash, to which is added 5 per cent. of tungstate of soda. The skins or hides are immersed six hours at a time in these tanks, then withdrawn and drained, and transferred alternately from the first to the second tank, and *vice versâ*, until the hide is sufficiently hardened. The condition of the hide is known by cutting a small piece off with a knife. At this stage they are immersed for six hours in a strong solution of tungstate of soda alone, then lifted, drained, and placed in a liquor of soap, made by dissolving 20 lbs. of soap in every 10 gallons of water, and the hides agitated in this until the strength of the soap is exhausted by being absorbed by the hide. They are now washed in soft water, and finally steeped for twenty-four hours in a common liquor of oak-bark, after which they are dried and finished in the usual manner.

Ballatschano and Trenk's Process.—This is one of the numerous *quick* processes, and is thus briefly described: In the treatment of horse hides, more especially, by this process a considerable increase in substance is said to be obtained. The hides are treated with the following tanning compounds, either singly, or in a certain order, or mixed together according to the kind of hide, its thick-

ness, and the various purposes to which it is to be applied. The compounds employed are: 1. A solution of chromate of alumina in pyroligneous acid (wood vinegar) in the proportions of about 1000 parts of water to 20 or 30 parts respectively of the chromate and acid. 2. A concentrated solution of argol,* to which is added a small quantity of a protoxide (such as nickel) in ammonia. The argol bath is said to have the property of considerably increasing the substance of the hides after treatment in the bath of pyroligneous acid and chromate of alumina, if the hides, after being removed from this bath and rinsed, are treated, while still wet, with the solution for twenty-four to forty-eight hours, or longer. The patentees state that the hides treated with the argol bath "are rendered so sensitive to vegetable tanning agents that a bath of 1 part tannin in 1000 parts of water and 20 parts of pyroligneous acid will tan a hide in thirty days, whereas a hide not treated with the argol bath will, with the exception of the brown colouring, show no trace of tanning under the same treatment." Tanning with the above ingredients may be effected in various ways. Thus, if 2 parts of solution No. 1 are mixed with 1 part of solution No. 2, the tanning of thick ox and horse hides can be completely effected in the mixture in from eighteen to twenty-one days. When possible to maintain the bath at a constant temperature of from 72° to 82° Fahr., the tanning can be more quickly effected. The raw hides to be tanned by this process are to be prepared in the usual way.

According to the purpose to which the finished leather is to be applied, different mixtures of both solutions, 1 and 2, are employed. For example:—*a*, 2 parts solution No. 1 and 1 part solution No. 2; *b*, the hides are first treated with solution No. 1, and then for any desired length of time with solution No. 2; *c*, the hides are merely treated with solution No. 1. A small quantity of carbolic acid is recommended to be added to the baths. The hides treated by the above process must afterwards

* Crude bitartrate of potash, as deposited by wine.

be carefully washed and then finished in the usual way. Before tanning, the hides must be completely freed from lime.

Lomas's Process.—This process consists in tanning with valonia, American pearlash, and oak-bark. For ordinary hides and skins four baths are used. The first bath is composed of a solution of valonia marking about 1° on Twaddell's hydrometer, and about 4 lbs. of American pearlash in 160 gallons of the solution. In this bath the hides remain about three days. The second bath is composed of valonia solution marking 3° Tw., and of pearlash in the proportion of 5 lbs. to 150 gallons. The hides remain in this bath four days. The third bath is composed of valonia solution at 7° Tw., and pearlash in the proportion of $5\frac{1}{2}$ lbs. to 150 gallons, in which the hides are immersed for seven days. The fourth or final bath is composed of solution at 2° Tw., and pearlash $2\frac{1}{2}$ lbs. to 150 gallons. Between each hide or skin, as they are placed in the bath, about 6 lbs. of oak-bark or valonia are spread, and in this bath they remain fourteen days. For very thick hides the first two baths are the same as for ordinary hides; they are afterwards placed in a bath composed of valonia solution at 9° Tw., and $2\frac{1}{2}$ lbs. of pearlash to 150 gallons of solution, in which they remain nine days. They are afterwards placed in a final bath, similar to that used for the other hides, for fourteen days. Instead of valonia, oak-bark or other equivalent tanning material may be used. The hides are *handled* in all but the last bath.

Michel, Kollen, and Hertzog's Process.—The object of this process is to ensure rapid tanning, by which calf skins may be tanned in a few hours, and cow or ox hides in about forty-eight, while at the same time the leather produced possesses all the flexibility and firmness indispensable to a perfect product.

To carry out the invention a set of apparatus is employed, the essential objects of which are, first, to regulate at will during the operation of tanning the temperature of the liquors in the operating tank and in the receptacle con-

taining the hides to be tanned; second, to regulate the density of the liquors in the said receptacle and also to change their nature as required for consecutive processes without interrupting the operation of the apparatus; third, the clarifying of the liquors used in former processes, in order to enable them to serve for future purposes; and it is by the combination of these means that, according to the present invention, rapid tanning may be effected. For these purposes the skins or hides are introduced into a drum revolving on horizontal trunnions, one of which is hollow, to admit of the passage of a suction-pipe leading from a pump, and a delivery-pipe leading from a raised liquor tank, both of which pipes descend in the drum within a partition thereof, so as to draw the liquor therefrom and discharge it into the same at or near its lowest point. From the pump a delivery-pipe passes up into the tank, so that by the pump the liquor can be withdrawn from the drum while this continues to revolve, and can be discharged into the tank, it being made to pass through a refrigerating apparatus on its way, while from the tank the same liquor may either be discharged back into the drum, after having been raised to any desired temperature by means of a worm heated by steam or hot water, or the liquor may be passed from the tank through the pipes into one or more filters in order to be clarified, the discharged clarified liquor being collected in other tanks, whence it can be drawn by the pump and discharged into the first-named tank again.

By these means, it will be seen that while the skins or hides are being continuously subjected to the action of the rotating drum, the liquor may at the same time be continuously made to circulate from the drum through the pump, refrigerator, and main tank back to the drum, whereby a constant definite temperature of the liquor may be maintained during the tanning operation, the action of the refrigerator and of the heating-worm in the tank being regulated to any required degree. Or during the operation the liquor may be continuously, or periodically, clarified by causing it to pass from the main tank to the filters

and thence back to the pump, as described. Or again, where the hides have to be subjected consecutively to a series of different operations, requiring different descriptions of liquors, these may also be all effected in one and the same drum by withdrawing the liquors therefrom by the pump at the end of each particular operation, and supplying the liquor required for the next operation from other tanks, which also communicate with the pump by pipes. The delivery-pipe of the pump also has a branch provided with a stopcock leading to a discharge drain, so that any particular liquor that has been employed in the drum and that is of no further use, can be withdrawn by the pump and discharged to waste, instead of being conveyed into the main tank again.

The apparatus is thus described:—"Fig. 24 is a longitudinal section, partly in elevation, and Fig. 25 is a plan. A is a wooden drum mounted to revolve on a horizontal axis, having at each side trunnions that work in suitable bearings. On the one trunnion is fixed a worm wheel, A^1, gearing with a worm driven by any suitable motor, causing the drum A to revolve slowly—that is to say, to make from ten to fifteen revolutions per minute, according to the nature of the hides operated on. The other trunnion is tubular, and through it pass freely two pipes, *a* and *b*, which are supported by an external bracket. The one pipe, *a*, bends downwards within the drum nearly to its inner periphery. A partition, *p*, having perforations through it, separates the body of the drum from the end space which the pipes *a* and *b* enter. A manhole, D, which can be tightly closed by a cover, serves to admit into the drum the hides to be operated on and to remove them. The drum has inwardly projecting ribs or studs, A^2, which assist in agitating the hides as the drum revolves. B is a pump having its suction communicating with the pipe, *a*, and its discharge communicating by a pipe, *d*, with the top of a service tank, E. In the course of the pipe, *d*, there is interposed a refrigerator, F, consisting of a sheaf of tubes within a casing supplied with cold water or brine that is cooled by a refrigerating apparatus, which is caused

to circulate through it while the liquid conducted by the pipe, *d*, flows through the tubes.

"The service tank, E, is placed at a high level on a platform supported by columns, so that there is free

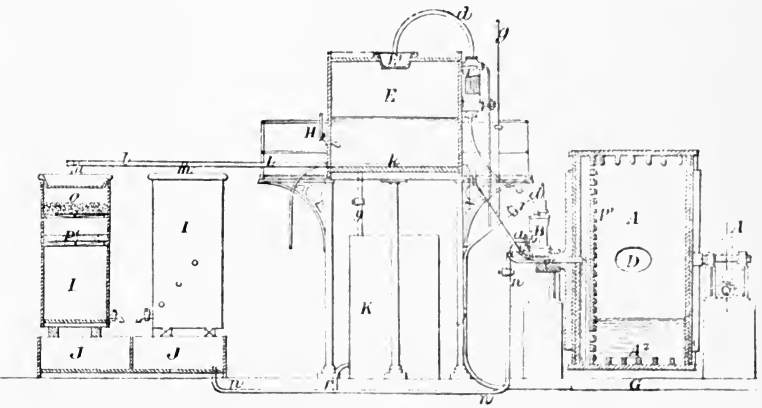

Fig. 24.

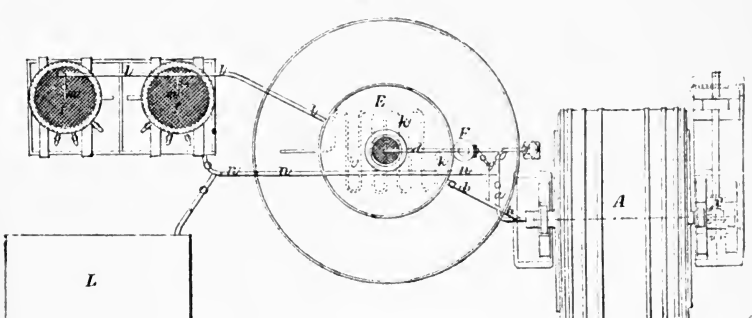

Fig. 25.

space under it. The top of the tank has an opening, in which is suspended a wicker basket, E^1, which serves to retain solid matters discharged along with the liquid from the pipe *d*. At the bottom of the tank, E, is placed a serpentine pipe, *k*, through which steam or hot

water can be passed when required to heat the contents of the tank. From the bottom of the tank the pipe *b*, provided with a stopcock, leads to the interior of the drum A. At the side of the tank is placed a thermometer, H, to indicate the temperature of the liquid in the tank. I I are filters, having within them perforated removable trays made of copper, on which are placed filtering materials, such as small pebbles, *o*, or a mixture of charcoal and Spanish white, p^1, to purify and clarify liquid conducted from the tank E to the filters J J, from which it is pumped back by the pump B, communicating with the tanks by a pipe, *n*. Other tanks, K and L, are provided to contain a reserve of liquid and to allow of subsidence, these reserve tanks being connected by supply pipes with the service tank E, and having branch pipes, *r*, connected to the suction-pipe, *n*, of the pump B. The branch-pipes to and from the several tanks are provided with suitable stopcocks, so that they can be charged or emptied as required.

"By means of the apparatus arranged as above described, the drum A, while it revolves, can be charged to any desired extent with tanning liquid supplied by the pipe *b* from the tank E, and whilst liquid is so supplied liquid can be withdrawn by the pipe *a* and pump B from the lower part of the drum, and returned to the tank E cooled, if necessary, on its passage through the refrigerator F, or heated, if required, by the serpentine *k*; thus the same liquid can be continuously circulated through the revolving drum with its temperature and quantity varied as required. Moreover, by causing the pump B to draw from one or other of the reserve tanks J, K, or L, the strength and quality of the liquid can be varied, while still its temperature can be regulated as above described. It is by a suitable regulation of the temperature, strength, and quality of the tanning liquid that acts in the drum A on the skins or hides which are kept in movement by its rotation, with suitable variations of these conditions at the successive stages of the tanning process, that we are enabled to effect rapidly and completely the conversion into leather of high quality. In order that the nature of the operation may be better

understood, we will, by way of example, describe its application to the two ordinary processes, so as to guide a practical tanner to its application in these and in other cases.

"I. *Tanning Process for Soft Leather.*—For calf and other soft skins the drum is charged with about 560 gallons of tanning liquor of ordinary composition, the tanning extracts which it contains being selected to suit the colour to be given to the leather. The density of the liquor should be from 30° to 35° of the tanning density gauge [barkometer], and its temperature 50° to 60° Fahrenheit. The skins to be treated with this quantity of liquor may weigh from 1,400 lbs. to 1,550 lbs., and these are introduced into the drum in their soft, hairless condition, along with soleine (essence of distilled turpentine), in the proportion of about 3½ pints of soleine to every 220 lbs. of skins. The drum thus charged is caused to revolve at a circumferential speed of from 400 feet to 410 feet per minute. In consequence of the 'fermentation' or action resulting, the temperature rises to 65° or 70° Fahr., at which it is maintained for four or five hours. It is then allowed to rise gradually to about 85° during a period of twelve to fourteen hours, at the end of which time the tanning is complete.

"II. *Tanning Process for Hard Leather.*—The process is similarly conducted, but extended over a longer period, according to the thickness of the leather, and with liquor strengthened by addition of about 5 lbs. of divi divi to every 100 lbs. of hides treated, or equivalent addition of other tanning material. For cow hide, for instance, the duration should be about 48 hours, the final temperature being allowed to rise to nearly 100° Fahr. At the end of the tanning operation the drum is almost emptied of liquor, and the hides are subjected for about fifteen or twenty minutes to the beating action of the revolving drum, after which fresh and very strong tanning liquor is gradually introduced into the drum, which is then kept revolving for about two hours. This has the effect of rendering the leather firm. The hides when tanned, whether for hard

or soft leather, when removed from the drum are soaked for several hours in a weak liquor at the temperature of the atmosphere. The liquors discharged from the drum are filtered and clarified, and restored to the required strength for a succeeding operation."

Keasley's Process.—This consists in the construction and employment of certain apparatus, whereby the operation of tanning hides may be more conveniently, advantageously, and effectually carried on than upon the ordinary plan. It is well known to all tanners that the quality and weight of leather is much improved and increased by occasionally removing the hides or skins from the liquor, and exposing them for a short time to the action of the atmosphere. The ordinary plan of doing this is by pulling the hides or skins one by one out of the pit by manual labour, with the assistance of a hooked instrument. This operation takes considerable time, and when the hides are large is a very laborious occupation.

By this invention a machine or apparatus is employed by which a much better result may be arrived at, and at the same time the operation may be shortened, the labour considerably diminished, and the weight of the leather increased. The apparatus consists of a square, rectangular, or other conveniently shaped frame, from which the hides or skins are suspended vertically in any convenient manner. The dimensions of the framing from which the hides are suspended must of course correspond with the size of the pit, so that the frame belonging to each pit, and with it the hides, may be raised or lowered at the discretion of the workmen. Each of these frames containing the hides is distinct and separate, and may be raised and lowered separately by manual labour, with the assistance of a windlass if required; but it is found advisable to connect two contiguous frames together, so as to make them counterbalance each other, and thus considerably diminish the labour of working them. A variety of means may be devised for carrying this idea into effect, but those shown in the accompanying drawings will be found fully to answer the purpose.

Fig. 26 represents a side elevation, and Fig. 27 an end elevation of one plan, in which the frames *a a a a*, filled

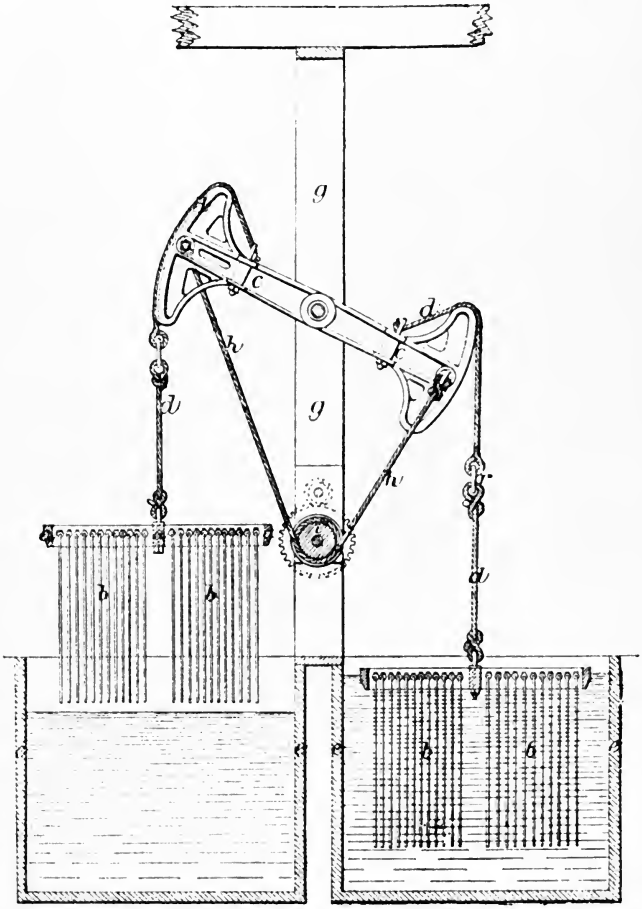

Fig. 26.

with hides or skins *b b*, are suspended from the extremities of a vibrating beam or lever *c c*, by means of chains

or cords *d d*. The tan-pits or vats *e e* are shown in section in both these figures. The beam or lever *c c* is mounted at *f* in bearings firmly fixed in the framing, *g g*, for that purpose, and is worked up and down by means of chains or cords, *h h*, which pass round a windlass or barrel *i i*, below, and are fastened at either end to the extremities of the vibrating beam. On the axle of the windlass is mounted a toothed wheel *j*, seen by dots in Fig. 28, and is driven by a pinion *k*, which is fixed on the shaft *l*, and is actuated by applying power to the shaft by means of a winch or otherwise. It will now be understood that as the pinion *k*, toothed wheel *j*, and barrel or windlass *i i*, are made to revolve, that one end of the beam or lever *c c* will be raised and the opposite end depressed by one of the ropes passing over and the other under the barrel, and by this means one frame of hides will be lifted out of the tan liquor while the hides on the opposite one are totally immersed. This operation may be reversed by merely turning the winch in the opposite direction. The ascent and descent of the frames is assisted by the forked guides *m m* (see Fig. 27), which work against the vertical guide-rods *n n*. At

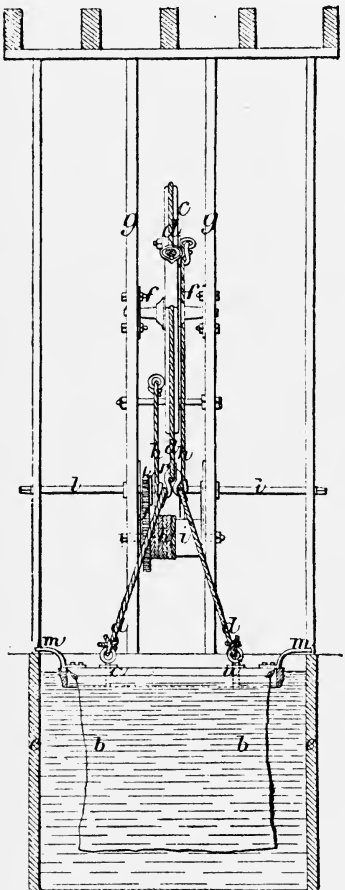

Fig. 27.

night or at other times when it is necessary that the hides on both frames should be immersed, this object is easily effected by unhooking from the suspending chains *d d*, by means of the hook *r*, the frame that is already immersed, and then allowing the other frame to

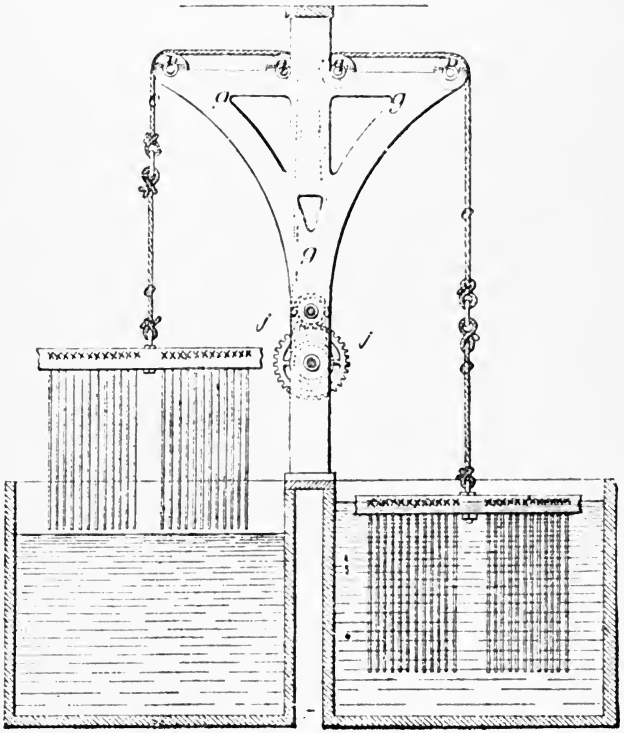

Fig. 28.

descend into the liquor, which it will easily do by its own weight. When one of the frames is raised, it is kept elevated by merely placing a leathern or wooden block between the teeth of the toothed wheel *j* and pinion *k*, and thereby preventing them from revolving. This stop

fully answers the purpose, and is found more convenient than a pawl and ratchet-wheel.

Fig. 28 represents a side elevation of another plan of carrying out the counterbalance principle. In this plan

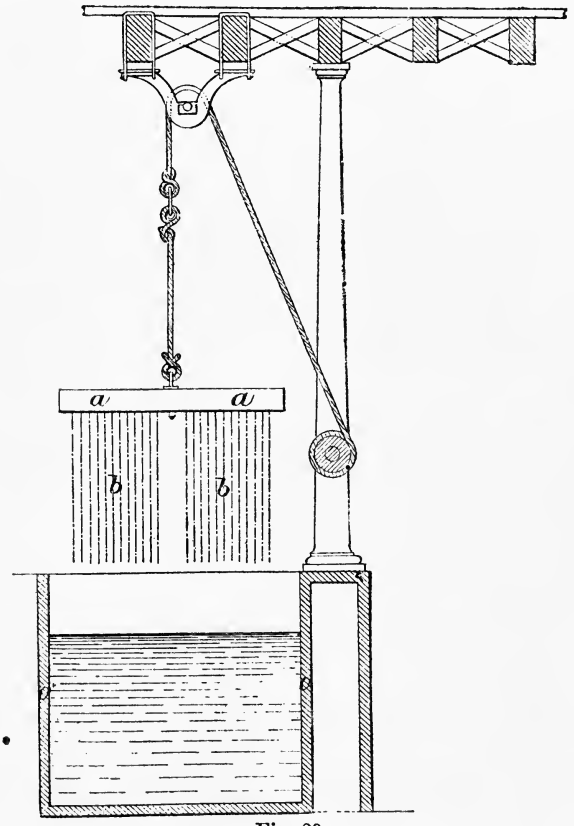

Fig. 29.

the vibrating beam *c c* is suppressed, and the suspending chains *d d*, and the working chains *h h*, are united together, and form the chains *o o*, which pass over pulleys *p p* at the outer extremities of the standards *g g*, and down between

the two other pulleys *q q*, and wind the barrel or windlass *i i*, as in the former instance. If, however, it is thought more desirable, the pulleys *p p* and *q q* may be attached to a beam, or the ceiling above, instead of to the standards *g g*. The barrel *i* is furnished with a toothed wheel *j*, and is driven by a pinion *k*, precisely in the manner already explained in reference to Figs. 27 and 28.

In Fig. 29 is shown a means of raising the frames containing the hides one at a time. In this case the pulleys are fastened as before mentioned to a beam above, the windlass or barrel being placed below.

Fig. 30 represents another plan of raising the frames. In this instance several frames, with the hides or skins suspended vertically, may be raised at one time, but not upon the counterbalance principle. The frames with the hides are raised by means of a rope *s s s s*, which passes over pulleys *t t t t*, affixed to a strong beam *u u u* above. One end of the rope *s s* is firmly fixed to the beam, as seen in the drawing, and the other end is passed over the pulleys *t t*, and round a windlass at the other extremity of the beam. The suspension cords of the frames are furnished with a pulley *v v*, constructed in such a manner that it may with facility be hooked on to, or detached from, the rope *s s*, according to whether it be required to raise the frames containing the skins out of the tan liquor or to allow them to remain immersed. It will be found most convenient to raise only one-half the number of frames at one time, leaving the remainder in the tan liquor. In order to do this the rope *s s* is brought down to every other frame, and the pulleys *v v* hooked on to the rope; then by turning the windlass and causing the rope *s s* to become coiled thereon, the frames, with the hides suspended therefrom, will be raised out of the pits, the other frames which are not attached to the ropes remaining immersed. When the first lot of skins have been exposed for a sufficient length of time to the atmosphere, the frames are lowered into the liquor again, where they are allowed to remain by unhooking the pulleys *v v*, which connect them to the rope *s s*, and those which were before immersed are

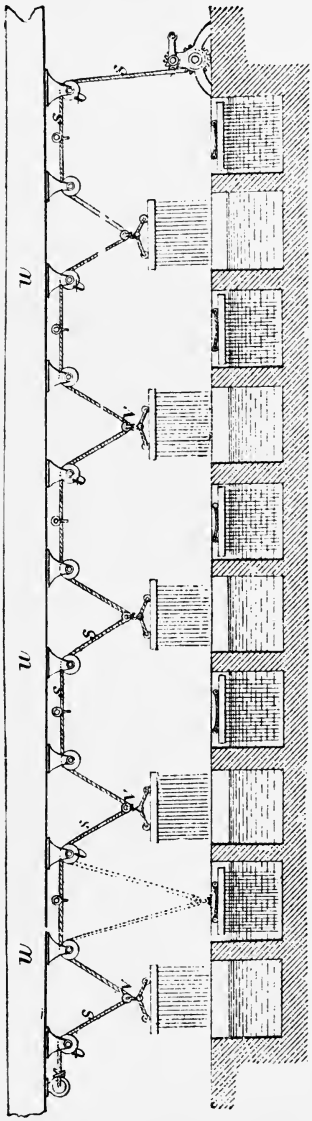

Fig. 30.

now to be raised by hooking them in their turn by means of their pulleys *v v* on to the rope *s s*. If thought desirable the counterbalance principle may be applied to this arrangement of raising and lowering the frames by merely employing an additional rope, *s s*, passed over pulleys, exactly similar to the one shown in the drawing. One end of this rope also would be firmly attached to the end of the beam *u u*, and the opposite end to the windlass or barrel; or instead of two ropes, one only may be employed by having it of sufficient length to pass from the end of the beam over the pulleys, round the windlass, back again over similar pulleys to the end of the beam, so as to present a double rope, to one part of which the three frames 1, 3, 5, would be suspended, while the other frames, 2, 4, 6, would be suspended from the other rope. Now, if a double rope, *s*, is employed there will be no necessity to detach the frames from the ropes; the pulleys *v v* are merely made to run freely on the ropes, and are not required to be constructed so as to hook on as before

mentioned. It will now be understood that if the counterbalance principle is carried out in this manner, one set of frames will be elevated while the others are immersed, and

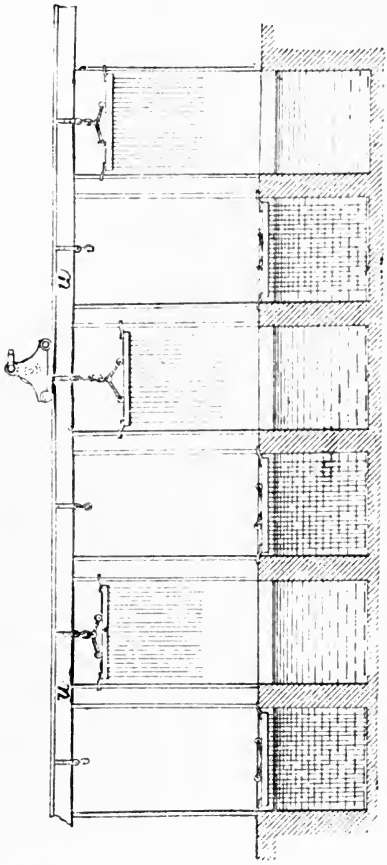

Fig 31.

the action of lowering one set will raise the other; that is, when the windlass is unwinding the rope to lower one set, it is at the same time winding up the other rope, and thereby raising those frames connected with it.

Fig. 31 represents another plan of raising the frames. In this plan a travelling windlass is used, which may be made to travel along a railway or floor constructed on the top of the beam above the frames. When it is required to raise a frame with its skins or hides, the windlass is moved along the railway or floor to immediately above the frame; then a rope with a hook at the end is let down to the frame, which is then attached thereto. The frame is then raised up by means of the windlass until the skins are drawn out of the liquid and are completely exposed to the atmosphere; the frame is then suspended from a hook, firmly fastened to the beam, where it remains until the manufacturer thinks it advisable to immerse the hides or skins. Again having raised one frame up and suspended it from the hook, the attendant releases the rope belonging to the windlass, and proceeds along the floor or railway with the windlass to another frame, which he raises and suspends from its hook in the same way. When it is required to lower the frames and their hides into the liquor, this must be done by means of the windlass in exactly the same manner.

CHAPTER XIV.

TANNING PROCESSES.—Continued.

Page's Process.—Casimir Bez and Sons' Process.—Snyder's Process.—De Bock's Process.—Funcke's Process.—Hamer's Process.—Cox's Process.—Nossiter's Process.—Desmond's Process.—Burbidge's Process.—Kleman's Process.

Page's Process.—By this process the hides and skins are limed in weak and strong solutions, unhaired "drenched" in hen manure or other suitable bate, and immersed and *handled* in colouring liquors made from equal parts of any suitable bark and sweet fern, cutch and sweet fern, or gambier and sweet fern. A mixture is then prepared with the following ingredients: 40 parts of common salt, chloride of potassium, or ammonium, 40 parts of alum, and 13 parts of saltpetre. These ingredients are thoroughly mixed and dissolved in four vats half filled with water. The vats measure 6 feet by 4, and are numbered 1, 2, 3, and 4. One-third more of the mixture is put in 3 and 4 than in 1 and 2 vats. After a "salt solution" has been thus prepared, a "tin solution" is prepared as follows:—To 2 gallons of the stronger salt solution are added 2 quarts of oil of vitriol, 2 gallons of muriate of tin of 140° to 150° Twaddell, 28 gallons of muriatic acid of 20° to 30° Baumé, and 2 gallons of nitric acid of 36° to 40° B. The hides are tanned by being immersed in the four vats successively, 1 pint of the tin solution being first added to the solutions in vats 3 and 4, and 1 pint added to each of these solutions whenever a fresh lot of hides are put in. The colouring liquor first described may, if desired, be made without sweet fern, or ex-

clusively from sweet fern. The tanning is said to occupy a very short time, and the leather produced is stated to be "exceedingly tough and close in fibre."

Casimir Bez and Sons' Process.*—This invention relates to the tanning of hides by aid of a continuous flow or current of tan liquor. The method is as follows: the raw hides are suspended vertically on poles arranged horizontally, and resting across the tan-vats or pits, which are on a gentle incline to encourage the flow of the liquid, and this latter is made and contained in vats at a lower level than the tan-pits. The tanning substances are deposited on a grating above the bottom of the pit in which the liquor is made, so that this pit has a double bottom; in the lowest portion is a suction and force-pump for raising the tanning liquor (made in this pit by admitting water above the tanning materials) to a reservoir above this pit, and a little above the tanning pits, which are a succession of vats arranged in pairs. This reservoir is provided with a grating near the top to prevent the passage of solid matters held in suspension, and being filled as described the liquid overflows through an aperture at the top of the first pair of pits, and fills the next pair; passing through an aperture at the bottom of the pits, it again fills the next pair, and passes through an aperture at the top, and so on, passing through openings alternately top and bottom, till it reaches the last pit. In this latter a pipe enters, and by a gentle slope leads the liquid back again to the vat or leach, in which it is made to go through the same course again, so establishing a constant flow of liquid of uniform strength, the skins being arranged vertically in each tanning-pit on the poles running longitudinally, so that the tanning liquor thoroughly washes the skins on all sides in its passage, and so impregnates them with the tannin. The reservoir containing the prepared liquid is provided with an internal agitator to prevent any deposit that might arise from being in a state of rest. When a double set of tan-pits, and two pits for preparing the liquors are employed, the same arrangement is adhered to,

and then a double-branched pipe leads the liquor from each of the last rows of vats back to their respective leaches.

The inventors observe: "Many systems and processes for tanning have been employed for replacing pit-tanning —which up to the present time has been the most successful, both in an industrial and economical point of view. For some years past it has been the custom to place hides in the pits not only horizontally, alternated by vegetable astringent matters, but also vertically, suspended across poles, so that the skins hang in a tanning liquid; but this arrangement, whilst submitting all parts of the skin to the immediate action of the tannin, has nevertheless failed to produce the results expected. The inventors attribute this to the decomposition of the tan liquor by remaining stagnant, the essential parts of the liquor precipitating, so that in a short time the skins are found in a mere neutral mass. The inventors conceived the idea of submitting the skins, whilst suspended in the pits, in a position parallel to each other, to the action of a tanning liquid which continually forms a double current across the skins and passes naturally from one pit to another, reaching the upper part of one to penetrate to the bottom of the next pit, and so on in succession, so that the constituents of this tanning liquid are constantly agitated so as to form a homogeneous whole, diminishing only in its action as it becomes more distant from its source of production."

Description of Drawings.—Fig. 32 is a section following the longitudinal axis of the pits as arranged, and as embodying this invention. Fig. 33 is a plan of the same, showing a twin or double arrangement. Fig. 34 is a detail on a larger scale. "The tannic liquor is made in the pits *a a*, at the head of the construction, and below the tanning-pits, the reason of which will be hereafter explained. The pits *a a* have double bottoms perforated with holes *b*, on which the vegetable astringent substances are placed. The water passing through these substances becomes impregnated with the tannin and passes under the bottom *b*, having

acquired all the requisite qualities. A suction and force-pump *c*, whose suction-tube c^1, debouches between the

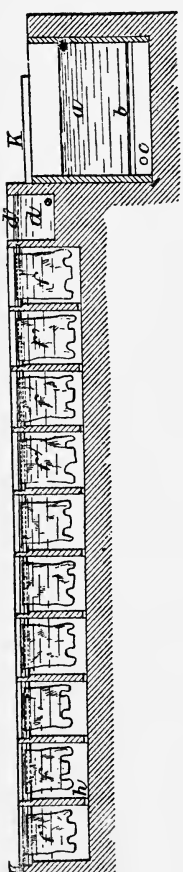

Fig. 32.

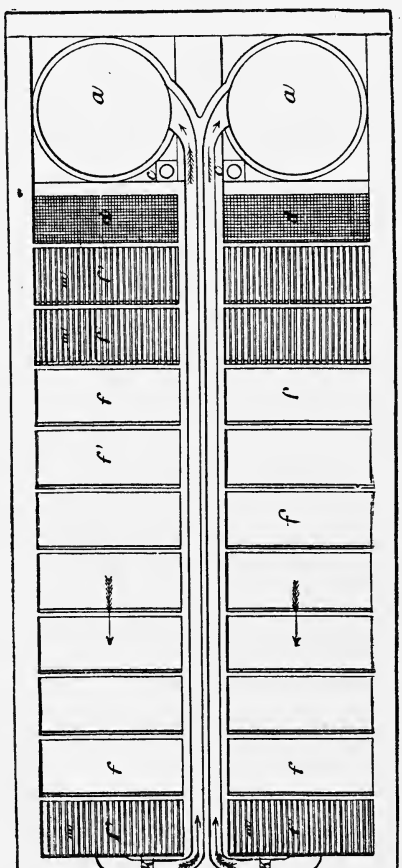

Fig. 33.

bottoms of the pits, transfers the tannic liquid to the lower part of the juice or liquid-pit *d*, the top level of which comes above a grating d^1, intended to stop the solid

matters held in suspension in the liquid. This liquor pit is furnished with an agitator gifted with two movements, an up and down penetrating motion and a simultaneous rotary one. In this manner the liquor, which would become hard from rest, is attacked not through the whole mass, which would require considerable force, but progressively, as fast as the agitator descends. Following the line with the pit *d*, are a succession of pits more or less in number and dimensions fff^1, all alike, and two and two, all having a fixed incline, to produce a natural flow of the liquid at a gentle speed, regulated as experience may prove requisite.

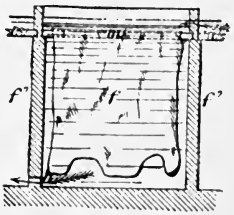

Fig. 34.

"The pits *f f* have their sides pierced at the top with holes, *g*, through which the liquid from the pit *d* reaches the first pit, and the liquor from the pit f^1 enters the second, and so on in succession till the last is reached. The pits f^1, whose sides are pierced below with holes *h*, consequently receive the liquor of the pits *f* (which precedes them) at the bottom, and the same pits *f* receive it at the top, the result being that the liquor from the reservoirs *d*, has a double flow of transfer from pit to pit, and of ascent and descent, in leaving the level of one to reach the bottom of the next successively until the last is reached. In this a pipe *k* is placed, reaching to the level of the liquid, and being gently sloped, the weakened liquid is returned to its source, viz., the pit *a*, and being renewed and strengthened, it is then forced by the pump to form a continuous current. In the pits $f f^1 f f^1$, the skins to be tanned are suspended on wooden poles *m*, resting across the partitions of the pit, all the poles being arranged parallel with the direction of the flow of the liquid. The skins consequently receive the action of the tannic liquor all over them, which, however, becomes weaker as the pits are further separated from the source of origin of the liquor, which is then returned as described to acquire renewed strength. As the strongest liquors are the

most dense, deposits are left at the bottoms of the pits, which are occasioned by the liquid resting all night; no ill effects, however, result from this, the skins being hung in the pits with the thickest parts downwards. Where double sets of pits are used, the liquor is returned to the leach *a* by a bifurcating pipe *k*."

After the skins have remained long enough they are removed from the first pit and replaced by those from the second, and then by the third, and so on till the last skins are reached; these are then put into the first pit, and fresh skins placed where the last were removed from. By this arrangement the skins throughout the pits that had received the action of the tan liquor, from the top to the bottom, now receive it from bottom to top.

Snyder's Process.—By this process the skins are subjected to *acupuncture* after unhairing, and previous to tanning. The skins or hides are punctured with small holes partly through, or are perforated with holes entirely through, either on the flesh or grain side, so as to admit the tannin more freely and perfectly through the skins. The best time for performing this operation is when the hide or skin is in its most relaxed state. The punctures may be made either with a hand instrument with steel points, or by passing the hide under or over a cylinder or flat surface covered with steel points inserted at proper distances, varying from 100 to 300 to the square inch.

De Bock's Process.—This process consists in immersing the skins or hides, after they are unhaired, in a solution of "mimosa catechu," subjecting them to handling, then immersing them in dilute sulphuric acid, and finally in water. In treating heavy skins, after having immersed them in the solution of mimosa catechu and handled them, they are taken out of the pit and drained; a solution of alum is added to the mimosa solution, as also a little vitriol, which are well stirred in. The patentee states that in place of alum a solution of sulphate of magnesia (Epsom salts) and mimosa catechu may be employed, but that alum makes the hides harder.

Funcke's Process.—1. The unhaired skins or hides are passed through a solution of commercial soda, and then hung up until nearly dry before subjecting them to the tanning process. 2. The skins are immersed in a solution of bark or other tanning material, to which is added a dilute vegetable acid. By this solution the pores of the skins are opened or extended while being exposed to the action of the tannic acid. 3. The skins and hides are again subjected to the action of a solution similar to the above, with the addition of a stronger solution of the vegetable acid, and its action is "softened" or mollified by the addition of a solution of sugar. Finally, while the skins or hides are subjected to the usual handling, they are treated with a solution of tannic acid until the leather is finished; but since the tanning liquor used in this process is of such strength as to impart too deep a colour for most purposes, the colour is reduced, when requisite, by adding, in the last stage of the process, sulphuric acid and salt to the tanning liquor in which the skins are worked. The skins or hides are partially dried after each operation before being submitted to the next.

Hamer's Process.—The inventor says, "I suspend the hides or skins within an air-tight vessel, so that the tanning liquor therein may come in contact with every part of each hide; I exhaust the air from the tank, and further keep the tanning liquor in motion during the process, so as to prevent it separating, and so that it may sweep off from the hides and skins the film of spent liquor immediately it is formed. The apparatus I prefer to employ is a rectangular wooden tank capable of being closed air-tight with a lid; within this tank is a frame somewhat shorter than the tank, and capable of moving to and fro endwise, this motion being given to it by a rod which is attached to the frame. The rod passes out through a stuffing-box in the end of the tank, and is there connected with an eccentric, or other similar instrument. The frame runs backwards and forwards in the tank on suitable guide rails, and the hides or skins are hung on

laths at the other end of the frame, transversely, the length of the tank. As the hides move to and fro, the tanning liquor presses first on one side of them and then on the other. The tank is connected with an air-pump, and is exhausted during the process. Tanning liquor partially used may be passed from one tank to another, and air may be forced into the tank which is being emptied, and when the tank is emptied may be forced up to a pressure of 5 or 6 lbs. to the square inch, so as to press out the liquor remaining in the hides."

Cox's Process.—In this process a frame is used with tranverse bars or cords, from which the hides to be tanned are suspended. The bars can be moved to and fro, so that the hides may be made to touch or not, as desired. The frames can be lowered into or hoisted out of the pit by any overhead traveller or other convenient mechanism. Inclined partitions are applied to the pit, which are preferred to consist of parallel fillets or bars, the edges of which approach but do not touch each other. One of these is at each end of the pit, but more may be used if desired. When the hides are first lowered into the pit they do not touch each other, so that the liquor may run freely between them. After a time, half the bars are moved towards one end of the pit and half towards the other end, so that the hides rest on or against each other and against the inclined partitions, so as to exclude the passage of the liquor between them. The hides are immersed in these two ways during the process of tanning.

Nossiter's Process.—This invention has for its objects, *First,* to employ frames or partitions to keep the hides or skins separate in the pits, and not pressed on by the hides and skins above. *Second,* pressing several hides or skins piled together in a press, in order to remove the spent liquor before again immersing them in fresh liquor.

Description of the Drawings.—In tanning hides and skins in pits, it is usual to pile them one on the other, so that the lower ones are much pressed on, and the tanning

liquor cannot pass to the two surfaces of each skin or hide, as it is desirable it should do. In each figure of the drawings the same letters are used to refer to the same parts. In Fig. 35, *a a* is a pit of the ordinary construction, and in place of having the hides or skins placed on each other in the liquor, they are separated by means of frames *b b*, which are of wood, and each frame simply consists of a quadrangular frame with crossbars, there being blocks, *b'*, to keep the frames separate, so that a skin or hide placed

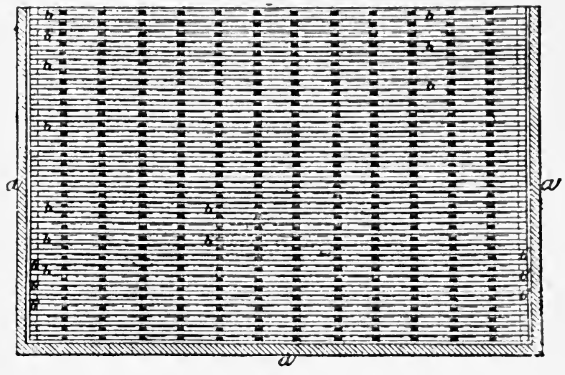

Fig. 35.

between any two frames, *b*, will not press on a skin or hide below, nor will it be pressed on by the skins or hides above; thus leaving each hide free to be acted on by the tanning liquor in every part of its surfaces, which will be found of great benefit in tanning hides and skins, and the process of tanning may be greatly quickened; and although a pit will contain less hides or skins by these means than when tanning in a pit in the ordinary manner, yet more hides and skins may be tanned in a pit in a given time than heretofore. In using this part of the process, the workman will withdraw the hides or skins from the pit from time to time, and submit them to fresh liquors, according to his judgment, as usual. The hides or skins

with the frames are first placed in a pit, and the liquor is then run or pumped into the pit. Fig. 36 is a ground plan of the frame.

The inventor states that the frames or partitions may be made of copper or any other material, instead of wood, and the hides separated by means of wire or network of twine, or twigs, and also by bars of any other material, and by any other means to which the principle of the invention can be applied. Although he considers it is

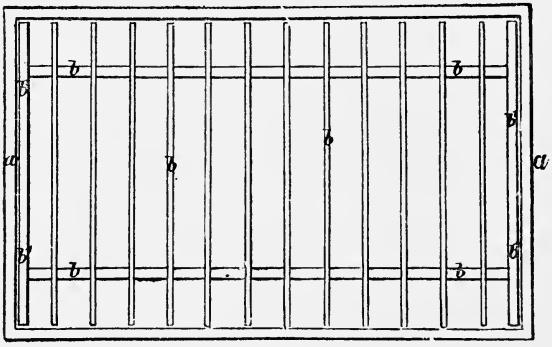

Fig. 36.

better that each hide or skin should be by itself, yet there may be two or more placed between each pair of frames or partitions, but he believes there will be proportionately less beneficial effect from this arrangement; and although he prefers that the skins or hides, with the frames, should be in a horizontal position, yet the system of keeping the hides separate may be carried out by using frames such as *c c*, Fig. 37, and fastening or lacing the hides or skins thereto by lacing threads *d d*, as shewn, the frames *c* having blocks *c'*, to keep them separate. Fig. 38 is a plan of the same.

He next describes the second part of his invention, which has for its object the pressing the spent liquor out of hides or skins before again submitting them to tanning liquor, and consists of using a suitable press, between the

surfaces of which a number of hides or skins are piled, and then pressure is exerted to bring the pressing surfaces, *e*,

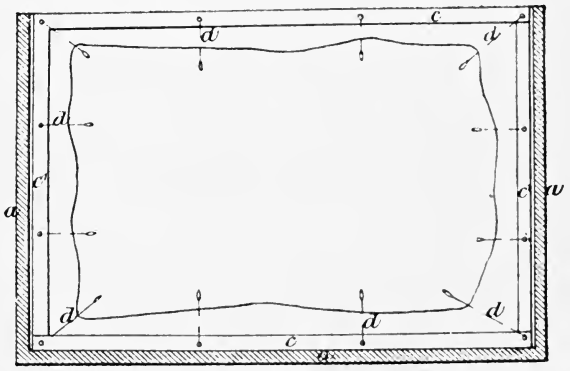

Fig. 37.

f, of the press to approach each other, and thus to express the liquor therefrom. The drawings (Figs. 39 and 40) show one description of press—a screw-press, where the

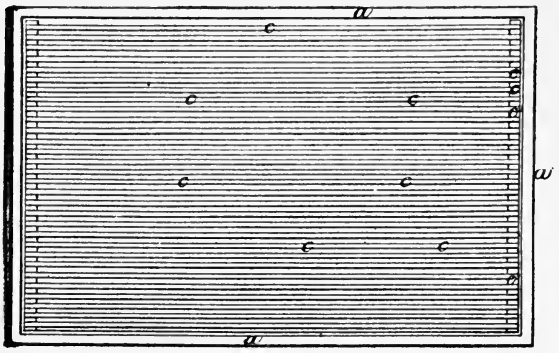

Fig. 38.

pressure is obtained by means of a screw *g*, acting on the surface *e*, and the other press (Figs. 41 and 42) is worked

by means of a roller *h*, and cords *i i*, as will readily be traced on examining the drawings. These or other presses

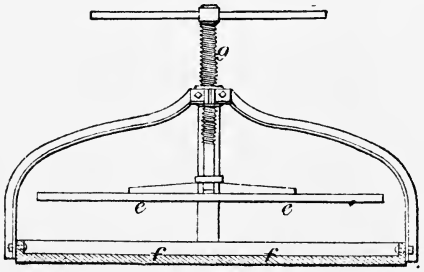

Fig. 39.

may be employed, the invention consisting of piling a number of skins or hides between two suitable pressing sur-

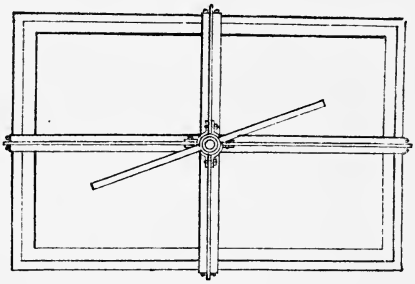

Fig. 40.

faces, and applying pressure thereto, so that the spent liquor therein may be expressed, and the skins or hides rendered better capable of imbibing fresh tanning liquor when they are again immersed in the pits.

Desmond's Process.—In this process the inventor employs saturated infusions of oak-bark or other tanning material, and when the bark is exhausted, he extracts what gallic acid is left by fresh water, to which liquor he adds $\frac{1}{1000}$ part by measure of sulphuric acid. In this liquor the hides are

immersed until the hair is easily removed. When the swelling is necessary, the hides are immersed in water acidulated with 0·05 parts by measure of sulphuric acid,

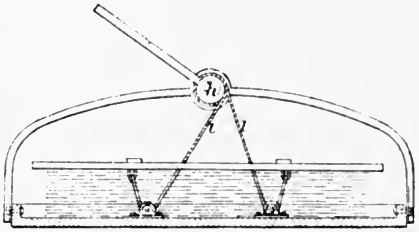

Fig. 41.

for ten or twelve hours. The hides are then washed and fleshed, and are next immersed for a few hours in weak

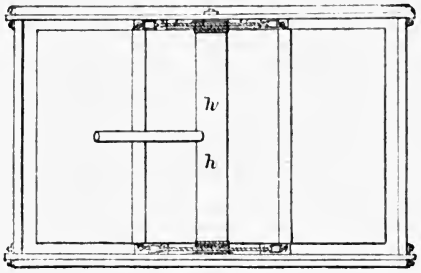

Fig. 42.

tan liquor, the strength of which is to be renewed when it becomes exhausted, till the skin is perfectly tanned.

Burbidge's Process.—The inventor treats the hides with the extract of oak-bark, which he says he obtains without loss of tannin. He regulates the use of this extract by the barkometer. He commences with a weak extract at 3°, the strength of which is increased successively by changing the liquor three times a week, carrying it to 20°, the strongest liquor being used when the tanning is near completion. By this process the weight of the leather is

increased. While by the ordinary process it takes a year to tan a hide weighing 80 lbs. when green, and which only weighs 40 lbs. when tanned, by this process it is said a similar hide can be tanned in three months, and it will weigh 40 lbs., which demonstrates that the excess of time employed is injurious to the leather. The amount of oak-bark used in this process does not exceed that of the older methods, being about four or five pounds for every pound of leather.

Kleman's Process.—Oak-bark, such as is used in tanning skins, is usually taken off while the tree is in sap. It is dried in order to preserve it, and it is introduced into the tanning-pit at the same time as the skins, together with the requisite quantity of water. But it will be understood that the tanning property as well as the chemical composition of the bark must vary according as the drying is quick or slow, and the greater or lesser period of time during which the bark is allowed to be exposed to dampness before the tanning begins. In most cases the bark commences to undergo acetous fermentation, which is completed in the tanning-vats. In order to utilise the tanning principle, whether obtained from oak-bark or gall nuts, to the best advantage, M. Kleman recommends the following method of procedure. The bark, while still fresh, is to be reduced to small pieces and placed in a cask, and sufficient water added to cover the material. The cask is then to be hermetically closed, so as to prevent the action of the oxygen of the atmosphere. The mixture is to be left undisturbed for a few weeks, so that the principles soluble in water may become thoroughly dissolved; after this the liquor is to be separated from the bark. If the liquor be now heated to from 113° to 115°, it will enter into *vinous* fermentation, and will then contain enough alcohol to mark 1° to 2°. If a skin be placed in this solution, it will become very quickly tanned, but will be hard and horny, owing to the concentrated condition of the liquor. If, however, it be diluted with water, excellent results will be obtained, and skins tanned in it will be more supple and the grain closer than when tanned by the ordinary method. Moreover, by this

method the same quantity of bark will produce more tanning matter. It is not advisable to boil the bark in water, because boiling coagulates the albuminous matter, which induces fermentation. The inventor has assured himself, by experiments, that bark which has undergone vinous fermentation gives much better results than that which has been subjected to *acetous* fermentation.

CHAPTER XV.

TANNING BY PRESSURE.

Spilsbury's Process.—Drake's Process.—Knowlys and Duesbury's Process.—Fryer, Watt, and Holmes's Process.—Mouren's Process.

The readiness with which tannic acid combines with the unhaired skin causes its exterior surfaces to become almost immediately converted into leather after immersion in the tanning liquor, by which the absorbent power of the skin is considerably weakened, and the interior fibres, in a degree, protected from the action of the tan. To overcome this drawback, and to favour the chemical action of the tannin throughout the entire substance of the hide, Spilsbury devised a mechanical method, for which he obtained a patent in 1823, by which the tannin was forced, by hydrostatic pressure, through the pores of the skin, and thus its perfect conversion into leather was ensured. The process is as follows:—

Spilsbury's Process.—The hides are unhaired and fleshed in the usual way, after which they are carefully examined, and if any holes are discovered these are carefully sewn up, so that the skins may be water-tight. Three wooden frames, of equal dimensions, are fitted to each other, and the edges of the frames secured together by screw-bolts. A skin is now laid upon one frame and stretched over its edges; then the second frame is placed upon it, so that the edges of the two frames may pinch the skin all round and hold it securely; another skin is then stretched over the upper surface of the second frame in a similar manner, and a third frame being placed over this, confines the second skin. The three frames are then

pinched together and secured tightly by the screw-bolts passing through ears set round their outer edges; by this means the skins are fixed so as to be operated upon by the tanning infusion. The space thus formed is of the nature of a bag, and is for the reception of the tanning liquor, which is introduced as follows: The frames being set upright, a pipe connected with a cistern above conveys the tanning infusion to the hollow space or bag formed by the two skins. The air is allowed to escape by a stopcock below, which is closed when the tanning liquor is introduced. The stopcock connected with the cistern-pipe is kept open when the bag is filled to allow the hydrostatic pressure to force the tanning liquor through the pores of the skin by slow infiltration, whereby the tannin is brought in immediate contact with its fibres. The effect of the pressure shows itself by a continual sweating of the tanning liquor at the outer surfaces of the skins. When the tanning is found to be complete, the upper stopcock is closed, and the lower cock opened to allow the liquor to run off. Finally, the frames are shifted, the bolts unscrewed, and the pinched edges of the skins cut off, after which they are dried and finished in the usual way.

Drake's Process.—The above process was followed, in 1831, by a patent by William Drake, a tanner, of Bedminster. By this process the hides were in the first instance immersed in a weak tan liquor, and frequently handled in the usual manner, by which they became partially tanned before being submitted to the infiltration process. Two hides, as nearly as possible of the same size, were then placed with their grain side in contact, and the two edges were carefully and firmly sewn together by means of shoemakers' waxed thread, by which a bag capable of holding tan liquor was formed. This bag was then suspended by loops, sewn to its shoulder ends, upon pegs in such a way that it could hang within a wooden-barred rack, and its sides pressed together in a book form. The upper end of this bag was left unstitched to the extent of about an inch, so as to admit a funnel, through which

cold tan liquor was poured until the bag was full. After a certain time, dependent upon the texture of the hides, the outer surface of the bag assumed a moist or sweaty condition, and drops would begin to appear at the bottom of the bag, which were received in a vessel placed beneath. The liquor thus collected was from time to time returned to the bag, and a constant supply of pure tan liquor also introduced into the funnel, so that the bags were always full. When the hides became hard and firm, while being uniformly damp from the exudation of the tan liquor, the temperature of the apartment, which had been kept well ventilated, was next heated gradually to from 70° to 150° Fahr., and the heat was kept up until the hides became harder and firmer in every part. As soon as the hides assumed black patches in places, and the tanning liquor ceased to diminish in strength, the tanning was found to be complete. The liquor was then run off by cutting a few stitches at the bottom, and the edges of the hides were then pared, and they were dried and finished in the ordinary way. To prevent the wooden bars within the rack from disfiguring the hides, the bags were occasionally shifted a little sideways. It is stated that by this process hides could be as perfectly tanned in ten days as in as many months by the ordinary methods.

Knowlys and Duesbury's Process.—By this process the hides are suspended in an air-tight vessel of rather larger capacity than their dimensions, and for this purpose it is lined with hooks, upon which the hides are hung at regular intervals, and kept expanded by means of weights attached to their lower ends. In the upper portion of the vessel or vat is an opening with a movable cover, for the entrance of the workmen. In the side, near the top, is a tube with a stopcock and coupling screws, for connection with an air-pump, and in a corresponding position, on the opposite side, is a similar tube for the admission of air, to create external pressure, if required. The tanning liquid having been introduced until it covers the hides, the vessel is hermetically closed, and then exhausted of air by means of the air-pump. As soon as the vacuum is established,

the contents of the vat are kept in repose for a day and night, after which the tanning liquor is drawn off, and the apparatus allowed to remain empty for two or three hours to permit the admission of air. This manipulation is repeated several times, or until the hides are sufficiently tanned. The ooze must be renewed after each exhaustion of the vessel, and the first liquid should be weak, but as the operation proceeds its strength must be gradually increased. This means of promoting hydrostatic pressure by the aid of a vacuum is stated to greatly accelerate the impregnation of the hides with tannin, and the process is said to be eligible both as regards quality of leather and economy of time and labour. The air being withdrawn from the pores of the skin, its resisting action, which prevents the rapid penetration of the ooze with the skin, is overcome.

Fryer, Watt, and Holmes's Process.—The object of this invention is to tan skins and hides by hydraulic pressure, which is effected as follows :—The patentees say, "We employ round upright tanks, to be made air-tight, and sufficiently strong to bear a pressure of from 10 to 12 lbs. to the inch, according to the time intended to be given in the process of tanning. These tanks are to be fitted internally with laths or hoops, or both, to attach each skin to separately at its full length ; the internal fittings of the tank to move upon centres, so that the skins, when once placed in the tank, will not have to be taken out until thoroughly tanned. The skins or hides having been arranged in their places, the hydraulic pump is then set to work, which forces the bark liquor (such as is used in the old process) into the tanks up to the required pressure. The bark liquor being now in the tanks, the fittings, with the skins, should be moved about four times a day for the first three or four days ; at the end of that time to be moved twice a day, and at the end of the fifth day once, until thoroughly tanned. The liquor is then to be drawn off, the skins removed and others substituted for them, to be treated in like manner."

Mouren's Process.—By this method a vessel, capable of

withstanding the pressure it is to be subjected to, is lined with lead, and it is furnished with manholes in the cover, which are made to screw on and off. Connected with, or standing upon, a vat containing tanning liquid, are placed two pumps, one communicating with the upper part of the vessel, and the other opening into a channel running up and down the side of the vessel, and which is perforated. The skins are placed in the vessel between two layers of tan; tanning liquid is pumped into the vessel at the upper part, and the entire vessel is filled; the pump communicating with the perforated channel is then used to force in more tanning liquid to any required pressure, which is denoted by a gauge on the pipe leading into the channel. The skins or hides are kept under pressure for periods varying with their nature and the purposes to which they are to be applied. The operation may be performed once or oftener.

CHAPTER XVI.

QUICK TANNING.

Quick Tanning.—Dr. Ure's Views.—Dussauce's Observations.—Dietz's Process.—Needham's Process.—Nuessly's Process.—Bell's Process.—Baron's Process.—Another Quick Process.—Guiot's Process.—Danish Quick Process.

Quick Tanning.—When we consider that by the old processes of tanning the conversion of hides and skins into good leather—and it *was* good—frequently occupied a period of about a year and a half, it is not to be wondered at that attempts should have been made to reduce the time required for perfect tanning by other means than those ordinarily adopted. In these days, with our greatly increased population and vast export trade, if we were dependent upon the old slow processes of manufacture, and upon oak-bark alone, how many of the industrial population would be compelled to go barefoot!

It has often been remarked that science has done less to improve the tanning art than has been the case with many other chemical industries. This is doubtless true to a certain extent; but it cannot be denied that from the moment the *principles of the art* were discovered and explained, commenced that great change in the *modus operandi* which has ever since been working, by slow degrees it is true, to develop a more speedy yet equally good method of tanning than that pursued up to the latter part of the eighteenth century. That the process of tanning can never be both quick and good, has been demonstrated by long years of experience almost beyond the shadow of a doubt. But that there is a *mean* between

the very quick and the very slow methods, which has now been arrived at, must, we think, be admitted.

That the conversion of gelatine into leather, or rather into *tanno-gelatine*, is not of itself a slow process is proved by the avidity with which that substance combines with tannin the moment these substances come in contact with each other; but, in the case of a hide immersed in tanning liquor, when once this effect has taken place upon its superficial surfaces, its powers of absorption—no matter to what extent the pelt may have been *raised* or swollen—are materially diminished, and before the tannin can find its way to the interior fibres of the skin it must of necessity remain for a lengthened period in the tanning liquor. Now it might naturally be thought that if by any plan the tan liquor could be *forced* throughout the entire structure of the skin, and thus all its fibres brought in direct contact with the astringent principle, that the operation of tanning would be rendered an almost instantaneous process. But is this so in fact? We know that by Spilbury's and Drake's ingenious processes the tannin was *forced through* the skins by hydrostatic pressure, until it eventually appeared on the external surfaces in the form of a perspiration; but though this would unquestionably prove that the astringent matter had permeated the entire structure of the skin, would not the *conditions* under which the tannin was introduced *keep the skin porous* when the operation was complete? Would even the after process of drying—which would naturally close the pores to some extent—enable the leather to acquire that hardness, firmness, and absence of porosity which slowly tanned leather is known to possess? In other words, although skins tanned by hydrostatic pressure would shrink and become more or less compact and firm after drying, would not moisture again dilate the pores when, say, boot-soles made from such leather were subjected to the effect of wet? In the ordinary slow process of tanning the expansion of the pores, beyond that which is induced by the process of *raising*, would not take place, but rather, by the weight of hides and tan in a well-filled pit, the pores of the skin

would be more likely to become closed to some extent *while the skin was wet*, and would become still more contracted during the after process of drying.

We would ask, does not the process of tanning mean something more than the mere conversion of the gelatine of the hide into the chemical substance called *tanno-gelatine?* As Sir Humphry Davy believed to be the case, does not the slow absorption of vegetable extractive constitute an important and *necessary* feature in the formation of leather? And if so, may not the union of gelatine, tannin, *and* vegetable extractive be naturally a slow process? If this be the case, we have merely to determine *how long* the process actually takes under the most favourable conditions. The *actual* period may be far short of the time allotted to the process by the old tanners—as it would naturally be when ooze is employed instead of water with the tan stratified with the hides; on the other hand, allowing for the advantage in speed which liquid tan must present, the period necessary to convert hides into perfect leather may *naturally*, under the most favoured conditions, be slow.

Dr. Ure's Views.—Upon this subject Dr. Ure makes the following important observations, and his reasoning, based upon Sir Humphry Davy's expressed views on the one hand, and the experience of practical workmen on the other, clearly indicates that not only is vegetable extractive a necessary constituent of leather, but that its union with the gelatine of the skin and tannin is essentially a slow process. "When calf-skin is slowly tanned in weak solutions of the bark, or of catechu, it combines with a good deal of extractive matter; and though the increase of the weight of the skin be comparatively small, yet it has become perfectly insoluble in water, forming a soft but at the same time strong leather. The saturated infusions of astringent barks contain much less extractive matter in proportion to their tannin than the weak infusions; and when skins are quickly tanned in the former they produce a worse and less durable leather than when tanned in the latter. In quick tanning a considerable quantity of

vegetable extractive matter is thus lost to the manufacturer, which might have been made to enter as a useful constituent into the leather. These observations show that there is sufficient foundation for the opinion of the common workmen concerning what is technically called *feeding* of leather in the slow method of tanning; and though the processes of this art have been unnecessarily protracted by defective methods of steeping and want of progressive infiltration of the astringent liquor through the skins, yet in general they appear to have arrived, in consequence of old experience, at a degree of perfection in the quality of the leather which cannot be far exceeded by means of any theoretical suggestions which have been advanced."

According to the foregoing remarks, there would appear to be, as we have suggested, an exact point, perhaps now determined, when the tanning process is known to be complete, without unnecessarily protracting the operation on the one hand, or unduly hastening it on the other. The tanning strength of the liquors being always uniform (though progressively varying in proportions of tannin), and the changes of temperature allowed for and calculated, might not the *actual* period requisite to produce a perfect leather be determined by a consecutive series of trials?

Dr. Ure further remarks, "On the first view it may appear surprising that in those cases of quick tanning where extractive matter forms a certain portion of the leather, the increase of weight is less than when the skin is combined with the pure tannin; but the fact is easily accounted for, when we consider that the attraction of skin for tannin must be probably weakened by its union with extractive matter;* and whether we suppose that the tannin and extractive matter enter together into combination with the matter of the skin, or unite with separate portions of it, still, in either case, the primary

* Considering the superior affinity of tannic acid for gelatine over vegetable extractive, is it not the former which retards the absorption of the latter?

attraction of the skin for tan must be to a certain extent diminished. In examining astringent vegetables in relation to their power of making leather, it is necessary to take into account not only the quantity they may contain of the *substance* precipitable by gelatine, but likewise the quantity and the nature of the extractive matter; and in cases of comparison, it is essential to employ infusions of the same degree of concentration."

In applying any of the quick tanning processes, the principles indicated in the above observations must not be lost sight of, while the practice must be in accordance with ascertained facts; otherwise the production of good leather may be more accidental than certain, even if it does not become impracticable.

Dussauce's Observations.—As to the time necessary for the conversion of hides into leather, Dussauce says, "Many tanners maintain that there is no advantage whatever in keeping leather in process after the tannin and gelatine have united. There is much diversity of opinion upon the length of time necessary or advantageous to keep leather in the tanning liquor, but it doubtless depends very much upon the preparation of the hide. Tanners generally do not pay proper attention to the early steps, those of unhairing and raising. Is there any necessity that time be given after the tannin and gelatine have united for leather to consolidate and grow? Is there any gain in weight, if even made more durable by the delay?" According to Ure's views, and the observations of the practical workmen to whom he has referred, an affirmative answer must be given to these two questions, if by "feeding the leather," we are to understand giving the hides sufficient time to take up as much *vegetable extractive* as they are capable of doing, and which, in a sense, would be allowing the leather to *grow* or its weight to become increased by the slow process necessary for the absorption of vegetable extractive.

Again, Dussauce asks, "What length of time is it necessary to let hides tan which are limed or sweated in the common method? These are questions often asked,

and on which the views of practical men are desired. The fact is, that when the tannin and gelatine are completely united, the process of the formation of leather is exhausted."

If vegetable extractive were not, as it has been proved by Davy to be, a necessary constituent of solid leather, this statement of Dussauce might be fully accepted; but we unhesitatingly give the preference to the views of Davy and Ure, because we believe that leather, properly so called, is a compound of gelatine, tannin, and vegetable extractive, and not merely tanno-gelatine. "But in the ordinary manufacture," Dussauce continues, "it is never the case that the hide has received all the tannin [and extractive?] of which it is capable, and therefore the extension of time is followed by an increase of weight. If all the gelatine of the hide could be exposed at the same moment to the action of the tannin, the process would be instantaneous." True; but the product would be *tanno-gelatine* and not *leather* proper. "There is no doubt that the improvements in this direction [quickening the tanning process] are feasible, and that a considerable time is now actually gained over the old periods of manufacture without any injury to the leather. But no improvement has yet so facilitated the quick production of leather that a material gain in weight may not be secured by a protracted stay in the vats; while attempts of this kind, by the use of deleterious substances, have resulted in rotting the fibre of the hide. Has there ever been any leather tanned in two, three, or six months, by any patented process, which has claimed to be equal to English bark leather? And what gives the great superiority of this class of leather, if not the length of time it is in the tan?" Undoubtedly a protracted exposure to the tan would give the superiority referred to, but is it not due to the vegetable extractive, and not the tannin, entering into the substance of the hide after the gelatine of the skin has become converted into tanno-gelatine? Does not the term "feeding" the leather really mean allowing time for the hide to *take up* as much vegetable

extractive as it is capable of doing, whereby not only is its weight increased but its quality improved? *

"It is well known," says Dussauce, "that the oak tanners of Pennsylvania and Maryland are about twice as long in tanning leather as the hemlock tanners. May it not be this length of tanning which gives the general superiority to oak leather? It is a general complaint that leather tanned by quick processes is wanting in solidity and strength. It is porous, easily filled with water, and wanting in durable qualities." These observations, like those from the same authority previously quoted, tend materially to strengthen the views propounded by the gifted observer Davy, to whose clear and original mind we are indebted for so much that is valuable both to science and to art.

We have been tempted to dwell thus far upon the comparative advantages and disadvantages of the slow and quick methods of tanning, in order that the reader, bearing in mind the support which *practice* has given to *theory*, may more readily form his own judgment upon the merits of the various processes which will hereafter be submitted to his consideration.

Dietz's Process.—The object of this invention is to swell the tissues and fibres of the skin previous to, and during the process of tanning, by the employment of saline liquors, whereby the skin is stated to be more readily affected by the tanning material; and in using in connection with such saline liquors tanning liquors of different and increasing strength, by which the centre and inner parts of the skin are tanned as quickly, or nearly so, as the outer surfaces. The inventor makes a weak liquor, at 2° or 3° of the barkometer, from any tanning material. In this liquor he mixes salt or alum in the proportion of two ounces to the gallon, and combines the whole by well stirring. The skins are immersed in this liquor and handled till they are saturated and the fibre fully swollen. The saline substances may be dissolved in water alone, without any tanning material, and the

* And which would not be attained if tan liquor only were used.

skins saturated with this liquor, and after complete saturation they are passed into the tanning bath. The strength of the bath is to be increased from 2° to 4° every day, and the skins stirred and handled until they are tanned. The time required for tanning by this process is—

For sheep skins	2 or 3 days.
„ calf skins	8 days.
„ heavy leather	30 to 40 days.
„ sole	40 to 50 „

Needham's Process.—In carrying out this process a bath is prepared consisting of—

Hempseed	1 peck.
Hops	1 lb.
Sal soda (soda crystals)	½ „
Animal brain	¼ „

The whole of the above are boiled in 8 gallons of water, and when ready is to be diluted with 40 gallons of water. The hides are soaked in this solution from six to thirty-six hours. They are put into a tanning solution composed of—

Catechu	12 lbs.
Divi divi	4 „
Alum	4 „
Salt	2 „

The novelty in this process consists in treating the hides in the above solution preparatory to immersing them in the tanning liquor.

Nuessly's Process.—The inventor first makes a solution composed of—

Pyroligneous acid (wood vinegar)	1 gallon.
Water	3 gallons.
Hydrochloric acid	4 ounces
Catechu	1¾ lb.
Alum	⅔ lb.

The whole of these are to be well mixed together by stirring. To 100 gallons of the above solution he adds—

Catechu	40 lbs.
Alum	10 lbs.

The hides are to be immersed in this bath, when in three or four days they will be tanned. Heavy hides require three or four weeks.

Bell's Process.—The hides being unhaired and prepared as usual, are to be immersed in tanning liquor from two to four days. The tanning liquor is composed of—

Wood-ashes	1 bushel.
Water	50 gallons.

After settling, draw off 40 gallons; to this is added 40 lbs. of terra japonica, and the whole boiled until the latter is dissolved. When cold, the solution is ready for use. The inventor says that by the combination of the alkaline ley and tannin he is enabled to prevent the tanning liquors from becoming sour or decomposed, and he is enabled to strengthen them without accumulating more than is necessary, and the skins will tan in a shorter time and with less labour than by other processes.

Baron's Process.—By this process the hides are prepared in the usual manner, excepting that they are soaked for three or four hours in river water, containing $\frac{1}{100}$ of hydrochloric acid, to neutralise any lime present in the skins; they are afterwards washed in river water. This treatment with the dilute acid completes the perfect swelling of the hides, and they are ready for tanning. Before tanning, however, the colour of the leather must be fixed, so as to be of the usual shade. For this purpose an infusion of oak-bark at 1° by the barkometer is taken, and to which $\frac{1}{100}$ of madder is added. The hides are immersed in this bath for six hours, so that the colour may be uniform. They are left to rest for an hour, then turned over every hour. After twenty-four hours the hides are ready for tanning in the following manner: Dissolve catechu in river water, according to the number of hides to be tanned. The liquor is placed in a receiver covered with a filter and provided with a "rubber" pipe to transfer the liquor to the vats. The first vat contains liquor at 1°, with a weak solution of alum. Into this the hides are placed, and are occasionally stirred during the first two

hours; afterwards they are handled every three hours. Next day they are placed in a vat containing liquor at 2°, and handled four times a day, then allowed to drain two hours. The strength of liquor is to be increased from day to day, until the hides are well tanned, when they are finished in the usual manner.

Another Quick Process.—To carry out this process air-tight copper vessels are used. When the hides are taken from the washing water the moisture is expelled by pressure; the hides are then packed in a drum fixed so as to have a rotary motion, and with them the necessary amount of tanning material is mixed, together with sufficient water to keep the contents of the vessel moist. The main hole of the drum is now closed, and the air pumped out as completely as possible. This being done, the stopcock is closed and a piece of lead pipe is added to the conducting tube. This lead pipe communicates with a tank containing tanning liquor of proper strength. If the stopcock be now opened, the tanning liquor rushes rapidly into the drum, and when a sufficient quantity has been admitted the stopcock is closed and the drum rotated for an hour, or half an hour, according to the quantity of hides contained in it. After two or three hours' rest the rotation is again resumed, and continued until the operation is complete. The advantages of this process are said to be that the pores of the skins are opened, and the tannin is not so quickly converted into gallic acid. The rotary motion facilitates the solution of the tannic acid of the bark, and helps its absorption by the hides, which are tanned in less time than without rotary motion. The following table shows the time occupied in tanning with and without rotary motion:—

	Without rotary motion.	With rotary motion.
Calf skins from	6 to 11 days	4 to 7 days
Horse hides	35 to 40 days	14 to 18 days
Lighter hides	30 to 35 days	12 to 16 days
Middling cow hides	40 to 45 days	18 to 20 days
Heavy cow hides	50 to 60 days	22 to 30 days
Ox hides, light	50 to 60 days	20 to 30 days
Ox hides, first quality	70 to 90 days	35 to 40 days

By the above process a large percentage of bark is said to be saved.

Guiot's Process.—The hides are depilated and raised as usual. Fifty hides are then treated in a vat of the following dimensions: width 3 feet, and height 4½ feet. The proportions of materials used for fifty hides are—

Catechu	150 lbs.
Water	50 gals.

Stir well until dissolved, and add 50 gallons of fresh water, and a solution containing 3 lbs. of lime; mix well together. The hides are to be immersed in this bath for eight weeks. During the first two weeks they are to be handled once a day; the last six weeks they are to be handled only once a week. Another bath is to be prepared by taking 25 gallons of the above liquid which has been used, and adding to it 25 gallons of fresh water and 6 lbs. of white vitriol (sulphate of zinc). These are to be mixed, and the hides placed in this bath for four days, with stirring every day. The hides are then removed and put into 125 gallons of fresh water, in which they are left for three days, when the operation is complete, and they are finished as usual.

Danish Quick Process.—The following rapid method of tanning, by which "dressing leather" may be tanned in two months, is practised in Brittany and elsewhere. The skins are first unhaired and fleshed as usual; they are then coloured by being barley and tan dressed, like barleyed skins, after which they are sewn up in the form of bags, apertures of about ten inches in length being left, through which they are filled with tanning solution. These openings being then sewn up, the closed bags are forcibly beaten all over for the purpose of distributing their contents equally throughout. They are then deposited in pits containing sufficient ooze to cover them completely, these pits being 4½ feet deep, the same width, and 8½ to 10½ feet long. When submerged in the pits, planks heavily weighted with large stones or weights are placed upon the skins, so as to press them down forcibly towards

the bottom, to increase the penetrating power of the infusion; and in order that they may be equally tanned on their different sides the planks are removed three or four times a week, and the bags are again thoroughly beaten and their position changed.

Skins prepared in this way are supple and pliable like crop leather, and have a finer colour than strong leather, but they are thinner than those made in the ordinary way, owing to their not swelling up by the slow process of feeding, and also from the pressure from within and without to which they have been subjected. "It is possible," says Morfit, "that the improvement of this process, which is now the old method combined with that devised by Seguin, may offer many advantages. The external and internal pressure mutually assisting, must certainly promote the introduction of tannin and extractive into the tissue of the skin. It is, however, doubtful if the durability and other qualities of the product are equal to those of leather prepared by more tedious processes"—an observation which is more or less applicable to every other process of quick tanning.

CHAPTER XVII.

HARNESS LEATHER TANNING.

Harness and Upper Leather.—Crop Leather.

Harness and Upper Leather. — The preparation of leather to be dressed for harness and boot uppers is in many respects different from that adopted for butt or sole leather; and, as will be readily understood, it must possess the utmost degree of toughness and strength which it is possible to obtain by the most careful means, from the first selection of the hide to the last operation of finishing. Although dry salted and dry flint hides may sometimes be employed for dressing purposes, there can be no doubt that the best hides for this class of leather are the recently flayed hides as they come from the slaughter-house. Hides which have been badly flayed, branded, or pitted with warble marks should be rejected. The hides employed for harness purposes are those of cows and smaller oxen.

Selection of Hides.—"A perfect hide for dressing purposes should be thoroughly flayed, free from warbles or warble marks, of a close, fine, glossy grain, without any scratches or brands, and well filled and level throughout. Now many hides may have all the first qualities, and may be full and plump at the back, but fall away at the shoulders, and nothing makes a more imperfect trace or rein if it is not of the same substance throughout. I know it is most difficult to get hides with all the requisites mentioned, but the only way is for the tanner to buy as many as he possibly can at the proper season of the year,

go to market where he gets the best selection, and go over the lots or piles of hides himself, feeling along the shoulders and neck, and only purchasing the lots where the fewest flat or thin hides are." *

Washing and Cleansing.—The hides are thrown into a pit containing clean water, to remove the blood, dung, and dirt, in which they remain for twenty-four hours. They are then drawn, and the horns and tail removed, after which they are again steeped for twenty-four hours. Dried and salted hides, however, require a much longer soaking, and must be effectually and thoroughly cleansed and softened before going into the lime. Old bate liquor is recommended as a good soak for dried and salted hides and kips. In former days some of the Leeds kip tanners considered this old soak so valuable that they worked it for many months without throwing it away. The fulling stocks are much employed for the softening of dried kips, and the beating action of the stocks, alternated by soaking, will generally bring them to nearly the condition of fresh hides in the course of a week or ten days.

Liming.—The method recommended by "an old Scotch Tanner" is as follows: "The hides being thoroughly washed and cleaned in the water pits, are drawn up and piled one on the top of another, hair upwards, next to No. 1, or the weakest lime pit. The lime liquor in the pit must be plunged with a plunger to raise the lime from the bottom, the hides thrown in, two men working at the hides and two men carefully laying them out and putting down with sticks. I allow them to lie for twenty-four hours in No. 1, or weakest lime pit, and draw them next morning, great care being taken not to scratch the grain of the hide with the hook. Ten hides are thrown aside from the top of the pack, and are put at the bottom. The hides are then put into No. 2 lime, which should be a little stronger than No. 1, spreading them out as was done previously. I allow them to lie in No. 2 lime twenty-four hours, then draw them and put them into No. 3 lime, changing ten hides again from the top to the

* *Scottish Leather Trader.*

bottom of the pack. No. 3 lime should be stronger than No. 2, and so on in succession, the last lime being the strongest and newest. I draw all my hides every morning, transferring ten hides from the top to the bottom of the pack each time, and changing them over to a stronger lime till they come to the strongest lime, where they lie, of course draining every morning, till they are ready for unhairing. If after eight days or so I find the hair not giving way, I add a little fresh-slaked lime to the liquor when the hides are lying up. It is impossible to give the proper quantity of lime that should be used (owing to its variable quality). Every tanner, if he pays proper attention to his limes, will soon find this out and regulate the quantity himself. Do not allow your limes to get old or stale ; the value of lime is not great, and there is far more to be lost by the hide being kept in weak old limes than in casting away the old lime and making fresh liquors. This, I think, is one of the causes why some tanners never get proper weight into their leather. The time I give my hides is from ten to twelve days, when they should unhair easily ; when unhaired, I throw them into a pit of clean water, to remove all superfluous lime that may be adhering to them, when they are ready for fleshing." We think there can be no doubt as to the danger of keeping hides for any length of time in exhausted or very weak lime liquors; and it is more than probable that limes to which the term "weak" is applied frequently contain little or no lime in an active or caustic state, from the fact that the lime liquors are constantly exposed to the action of the atmosphere, from which they are continually absorbing carbonic acid, converting the caustic into carbonate of lime, which can have no effect upon the hides, while the liquor not being caustic would naturally have the same solvent action upon the gelatine of the skins as water, and would therefore reduce their weight.

Bating.—After liming, unhairing, and fleshing, the pelts are *bated* in a bate of hen manure, or, according to the practice of the tanner, they are treated in boric or lactic acid solutions, &c.

Tanning.—The pelts are treated in the handlers in the same way as those intended for sole leather, except that they are not kept in the old and sour liquors for a lengthened period, but merely sufficiently long to "clear the grain," as it is termed. They are next treated in weak sweet liquors of progressive strength, the liquors being returned to the leaches to be strengthened, as usual. The strongest liquors in the handlers should not exceed from 10° to 12°. The hides are treated in the handlers for about a month or six weeks, being worked in a *round*, after which they are placed in pits containing stronger ooze and finely ground oak-bark, being worked in a round as before, for two or three months, after which they are stratified with ground oak-bark in the layers, and treated with a still stronger ooze. After about six weeks the hides are taken out, and again laid down with interposed layers of ground bark and strong ooze, and in these pits they remain for about two months, the process being repeated once or twice more, until the tanning is complete.

Crop Leather.—Crop leather, now almost extinct, included the leather prepared from the hides of cows and small oxen, the former (provided the cow has not calved) yielding the strongest and toughest leather of the two. As a general rule the stoutest and most compact or compressed leather (from ox hides) is used for sole leather, but not unfrequently leather made from crop hides was devoted to this purpose, without being rolled and condensed by the tanner, as in the case of *butts*. The lighter cow hides are used for the uppers of stout shoes and boots, inner soles, and also for water-boots, and other purposes. The hides of young oxen, being deficient in firmness and thickness, are chiefly used for *belt* leather. In the treatment of crop hides, they are first submitted to the usual preliminary operations, and are then placed in the lime pits until ready for unhairing, which in summer is usually in about eight days, and in winter from ten to fourteen days; they are then sent to the beam-house, where, after unhairing, they are fleshed with great care, being frequently rinsed

each time, in running water if practicable, to remove the lime as far as possible. The hides intended for uppers require at least four or five rinsings, while those which are to be used for sole leather require but two rinsings. They are next *raised*, either by immersion in dilute sulphuric or hydrochloric acid, according to the tanner's practice; and they are then placed in the handlers, in weak ooze at first, in which they are handled daily in the same way as butts, and are afterwards treated in stronger ooze, and handled as before during a period of four or five weeks. They are next put into the layers, in which they are carefully spread out, with alternate layers of finely ground oak-bark; the pit is then filled up with ooze. At the end of about six weeks they are taken out and subjected to a fresh change of bark and ooze, this being repeated once or twice more until the hides are perfectly tanned.

CHAPTER XVIII.

AMERICAN TANNING.

Cold Sweating of Hides.—Sweat Pits.—Treatment of Hides in the Sweat-pits.—Treatment of Hides after Sweating.—Liming.—Unhairing by Prof. Lupkin's Process.—Beam Work.—Trimming or Rounding.—Grinding the Bark.—Leaching.—The "Press" Leach.—Raising with Vitriol.—Handling.—The Rocker Handler.—The Layers.

WHILE our American cousins freely and generously acknowledge the excellence of English tanned leather, and highly compliment our manufacturers upon the care and economy with which they conduct their various operations, there is much in the Transatlantic system of tanning which deserves and must command attention. If, however, our great American competitors were as silent upon the subject of which we are treating as are our own countrymen—with few exceptions—we should have but little to communicate as to the *modus operandi* adopted in the United States. The whole fraternity of tanners, however, both at home and abroad, are indebted to Mr. Jackson S. Schultz, an eminent American tanner, for a very clear and practical book on the manufacture of leather* as conducted in the States, being the substance of a long series of valuable papers contributed by him to the Boston *Shoe and Leather Reporter*. Independent of the great service which these writings must have rendered his own countrymen, there is a great deal of information conveyed by the pen of this astute writer which should be read by all who follow the art of tanning, even though they treat specially of the method adopted in the United States.

* "Leather Manufacture." By Jackson S. Schultz.

We now purpose giving, as briefly as possible, a *résumé* of the American system of tanning, as explained by Mr. Schultz, but must refer the reader to his own admirable work for more complete information.

Cold Sweating of Hides.—While in Great Britain sheep skins are freed from their wool by "steam sweat," as it is called, in the United States a system of *cold sweating* is adopted for heavy hides which at present is chiefly confined to that country. Schultz says, "It is now demonstrated that a wooden, brick, or stone structure, on the top of the ground, can be so completely protected from the rays of the sun and other atmospheric influences as to make a good sweat-pit. The ice companies have adopted surface structures of wood filled in with sawdust, tan-bark, or charcoal between the outside clapboards and the inner linings of their buildings, and this same form of structure will make a most serviceable tanner's sweat-pit. But since the sweat-pit is subject to greater changes of atmosphere than the ice-house, it is desirable that the inner lining of the sweat-pit should be of a more enduring substance than wood. The damp but warm atmosphere of tanners' sweat decomposes the fibres of the wood very fast. On account of this liability to decay, if for no other reason, the sweat-pits of the tanners should be constructed of stone or brick.

Sweat Pits.—"The structures may be wholly above ground, and should be so placed that a wheelbarrow may be run from the floor of the beam house to the main passage-way of the sweat-pit. These passages should be wide—not less than 6 to 8 feet—and be so thoroughly lighted both from top and ends as to make their passage by workmen and employés both easy and agreeable. The height of this main passage-way should extend above the surrounding pits, and by this 'lantern' construction both light and air can be secured in the passage-way below. The pits themselves should extend from both sides of this main passage, and be connected with folding doors wide enough, when fully open, to admit a wheelbarrow."

Each of such pits must be large enough to hold one

pack of hides, and high enough to allow the suspension of a side doubled, with 2 feet clear above and 1 foot below the hooks. The pits should be about 8 feet wide, giving space for two tiers of sides and gangway for the workmen. The pits should be so constructed that light may enter sufficient to allow a close examination of the hides without the employment of a lamp, and should be kept in such a cleanly condition that any person could enter the pit without soiling his clothes. Mr. Schultz lays great stress on this point. The temperature of the pits is kept under control by *steam* and *cold water*, which are admitted through the main passage by means of pipes. "A properly constructed pit should have a false bottom, under which the steam may be forced, to find its way, in condensed spray, up through the suspended sides. This process will adequately warm the pit. When too warm, cold water may be thrown from the mouth of a sprinkler over the whole surface, and thus, in a few moments, cool the whole space, and leave a desirably moist atmosphere." The temperature should be maintained at from 60° to 70°, with globules of moisture resting on all parts of the suspended hides, which eventually collect and drop from points of the hair.

The sweat-pits are covered by stout timber, above which is a layer of earth about 2 feet thick, which is kept well watered, so as to protect the interior from the heat of the sun's rays. The sides of the pits may be protected with the same object, either by means of earth or spent tan. With pits so constructed hides may be properly "sweated" in from three to seven days—usually about four or five if the hides are in proper condition. The cold sweating process is, however, chiefly adopted for dry "flint hides." Before submitting the dry hides to the sweating process, they require to be softened or brought to the condition of green hides by the usual methods of soaking, beating, &c.

Treatment of the Hides in the Sweat-pits.—The hides should be hung on the racks by tenter-hooks, being suspended either from the shoulder or from the butt, but

whichever method is adopted the same should be applied to all, so as to ensure uniformity of action in the sweat-pits. Since the sweating is more rapid above than below, and as the thicker parts of the hide will resist the action of the sweating longer than the thinner parts, it would be better if the *pates* and *butts* could be suspended higher than the bellies and shoulders; but since this would involve considerable difficulty, the same result is attained by changing the position of the hides after three or four days, when the process of sweating will have advanced considerably. This operation of "assorting out," as it is termed, requires great care on the part of the workmen, since upon this in a great measure depends the success of the operation. This care is specially necessary at this stage, since no two hides, however uniform in character, will sweat exactly alike. "No hour in the whole day," says Mr. Schultz, "should be without a visit to the advanced sweats. When a few sides give indication of 'coming' prematurely, before their proper time, they should be dropped to the bottom of the pit, and allowed to lay in piles until their less advanced companions catch up in the process of decomposition."

Treatment of Hides after Sweating.—The sweated hides are next thrown into the mill for a few moments, to wash away the dirt and "slime," and to rub as much of the hair off as can be removed by such means. In respect of this operation, however, Mr. Schultz says: "During this short and damaging process two things happen—1. The loose hair is fulled into the flesh so firmly as to make it difficult to remove afterwards on the beam; and 2. To pound out much of the gelatine of the hide, which at this period is almost in a soluble condition, and will part from its proper lodgment in the fibre almost as freely as the slime and dirt with which the surfaces are supposed to abound. Indeed, much of the substance that is regarded as 'slime' and 'dirt' is the gelatine, which, when combined with tannin, goes to make leather." He very properly condemns the practice of fulling or milling the hides after sweating, which must reduce their weight

considerably, besides disturbing the delicate structure of the hide itself. The system which many intelligent tanners of the States have found most practical is to throw the hides as they are removed from the sweat-pits into weak lime liquor for a short time, by which a slight plumping or swelling of the hides takes place, and the slimy condition disappears, while the hair does not attach itself to the flesh as in the former treatment. He advocates part liming and part sweating as a good method of loosening the hair.

"There can be no doubt," he says, "that our American system of cold sweating is calculated, beyond any other known method, to make a firm, compact fibre when properly used, and besides it is specially adapted to the preparation of the dry hides of our continent. It only remains for me to say a word on the subject of 'grease' and 'salt,' as among the hindrances which affect and control the sweating of hides. All sweat tanners fully understand that the salt (if the hide is salted or pickled) must be fully soaked out before the hide will sweat. From this, among other circumstances, is deduced the inference that this process is a decomposing one, for, so long as the hide is held (cured), from the presence of salt, carbolic acid, and other tanning ingredients, the sweats will not operate on the hide. So, too, if this is covered with grease, as many of our Western and Californian hides are, it will not sweat evenly, owing to the presence of the grease on some portions more than others."

Liming.—The method of preparing the lime liquors in America is in many respects different from that generally adopted in this country, one point of difference being that less lime is employed than is usual here. After recommending that the lime should be kept in dry and confined apartments, where neither moisture nor air can reach it, Schultz recommends that a half hogshead should be placed near the lime-vat which has to be replenished. For a pack of 120 to 140 hides about a bushel of lime is put into the tub, and one or two pails of water poured on; the vessel is then to be covered with thick canvas. As the

water is absorbed more is added if required, but our own experience in the slaking of lime teaches us that a much less quantity than two pails of water would be sufficient to slaken a bushel of lime. It is always a great advantage to cover up the vessel in which lime is slaked, since by so doing much less water may be used, and the confined steam aids the slaking greatly.

Whereas in this country it is usual to put a considerable quantity of lime in the pits, Mr. Schultz says, "Nothing but pure limewater should ever be allowed to enter the vat. This will not only render frequent 'cleaning out' unnecessary, but will save the flesher's edge, and also save time in many respects." He allows three or four days only for the liming, and in this time "the lime will not improperly fill the hide, and when unhaired it may be speedily reduced to a proper condition. The reduction (depilation) will be well begun by throwing the hides or sides into a wheel (drum), and with a flow of warm water turned on run them for ten minutes. The advantage of warm instead of cold water is very marked, and may at this stage of the process be freely used with safety. It is always safe to use on hides filled with lime heat to the extent of 110°. . . This rinsing process will remove the greater portion of the lime, and will ordinarily prepare the hides for the liquor." Some tanners, however, to get rid of the lime more effectually, use hens' dung or sour bran liquor. This latter precaution, however, is not considered necessary for sole leather, while for upper leather, it is necessary that the skins should be as free as possible from lime before they go into the handlers. The sour liquors of the handlers are deemed sufficiently active to remove the lime from heavy hides, provided the fibre has not been unduly strained in the beam house.

Unhairing by Prof. Lupkin's Process.—By this method one tanner in New Jersey prepared not less than 50,000 hides annually with great success. His packs were made up of about 50 hides each, either cured, green, salted, or dry Buenos Ayres or Rio Grande. The green weighed about 50 lbs. and the dry about 20 lbs. For such a pack

80 lbs. of lime would be slaked, but the lime was not watered after slaking, as usual, but was left in the condition of a thick paste. A small portion of this was kneaded thoroughly with 10 lbs. each of soda ash and powdered sulphur. When these substances were well mixed, they were thrown into the tub in which the bulk of the lime reposed, and while this was still warm; the whole were then thoroughly mixed, and the tub then filled with lime liquor and the whole well stirred. When this was done, the mixture was poured into the vat, and the whole thoroughly plunged. No more liquor was employed than would be sufficient to cover the 100 hides when thrown in. The lime was kept up to summer heat by the application of steam. The handling was performed once or twice a day, if thrown into the vat as usual. Mr. Schultz says, "There is no doubt that it is a good method of unhairing for any hides or skins, and when a soft and smooth grain is desirable it is a valuable improvement. Of course, it is slightly more expensive than pure lime, and, for this reason, has not found general favour." The soda ash in this process combines with a portion of the lime, forming *caustic soda.*

By another process the hides, after the usual preparation, are thrown into a strong lime for 8 or 10 hours, when they are taken out and immersed in water up to 111°. The warm water soaks, softens, and swells the roots of the hair, and has much the effect of the "scalding" applied to hogs. "So little lime permeates the inner fibre, that, after a slight wheeling, the hides may be thrown into cold water and allowed to cool and plump preparatory to taking their place in the handlers. The process is strongly commended for sole leather, particularly where great firmness of fibre is desired. The tanner who tries this method must be satisfied if he gets twenty to thirty sides per man, unhaired and fully completed for the liquor, per day." Instead of the usual handling in the lime, the hides may be "strung" together, and reeled over from one pit to another by means of the *hand-reel,* Fig. 43. This simple contrivance for removing hides from one pit to another, as a substitute

for the usual handling, should command attention. In speaking of its capabilities Schultz says, "The facility with which packs may be thus transferred from one pit to another commends this skeleton reel to all tanners. It is safe to estimate the performance of this machine with two men as equal to that of six men by the old process. Besides, it does not require either man to stoop to his work, and the labour is therefore easier. The stand and

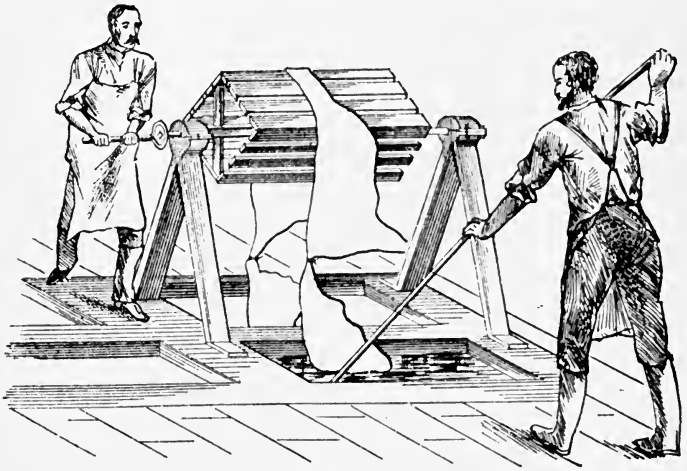

Fig. 43.

skeleton drum should be made of as light material as possible, so that its transfer from one vat to another may be effected by two men with ease. As there need be but one of these reels in an ordinary sized tannery, the tanner can well afford to have the frame, drum, and bearings made of substantial but light materials, well adjusted in all parts, even with brass bearings. Two men can shift 10,000 in ten hours. The hides may be tied together with strings."

Beam Work.—"No amount of labour and care," says Mr. Schultz, "in the after processes can atone for neglect in this department. The flesh should all be removed, and the

natural structure of the hide (pelt) should not be disturbed or even touched with the edge of the flesher.*. . . The usual flesher and half-round beam are too familiar to the tanner to require notice in this connection, but within a few years the French and German beam-knife has been introduced, and received with general favour. This knife is about one-third larger than ours, and is not more than two inches wide; the material is the best steel, and is not more than a quarter of an inch in thickness in the rib or centre. The blade is so supple that the handles can almost be brought together. It is claimed for this knife that by its supple nature it bends around the rounded convex form of the beam, and makes a flatter cut on the flesh of the side, less concave than a stiff, straight-edged flesher cutting on an oval or convex surface. To this extent the new knife certainly does present advantages, and may be safely trusted to do good work in skilled hands."

Trimming or Rounding.—This author speaks highly of the economy and judgment displayed by the English tanners in their method of *rounding*, and gives the following reasons why this method is adopted:—1st. The shoulders and offal are much thinner than the butts, and, therefore, tan in a shorter time. 2nd. The offal being used where a tough fibre is required, slack, or at most a full tanning, is all that is required. 3rd. The boot and shoe manufacturers, not only of Europe but of America, have so classified their work that those who use butt leather largely do not require so much "inner soleing" and "welting" as would come from the bellies and shoulders of these out-soles.

Mr. Schultz says, "It is probably true that the population of Great Britain is better and more economically shod than any other people in the world. A portion of the economy is due, however, to iron rather than leather.† Much of the economy here conceded arises from their method of trim-

* Fleshing-knife.

† This remark is specially applicable to the present time, when metal sole and heel "protectors" are so extensively applied by the public themselves.

ming and rounding their hides and skins. That which belongs to the glue-maker never goes beyond the beam house in any tannery in Europe."

Grinding the Bark.—In the United States the spent tan is largely used as fuel by the tanner for the generation of steam for his grinding-mills, for the leaching of bark, and other purposes, and to a great extent has supplanted the use of all other fuel, and even water-power. "So absolutely inexpensive is this substitute," says Mr. Schultz, "that power and heat may be used without stint and limit in the manipulations of all our modern sole leather tanneries. . . . The fact, then, stands conceded that the wet spent tan from an ordinary sole leather tannery will give ample power to grind all the bark and heat all the liquors required." He writes strongly against mills which grind at high speed, and doubts whether a motion over 80 revolutions per minute is either profitable or effective. The benefits which may be derived by adopting a higher speed in nowise overbalance the defects in grinding and danger of fire from excessive friction. "A quick motion has the effect to 'throw up' and 'back' the bark, rather than take it in and pass it through the grinding surfaces, as a slower motion will." He recommends 80 revolutions on a small and 70 revolutions on a large mill as the proper motion.

Speaking of the American methods of grinding and leaching, Schultz says it is estimated that from 7 to 10 per cent. of tannin is left in the bark, and it is doubtful if any of their methods will take out the remainder profitably. He says, moreover, that "the time may come when hemlock and oak-bark (the chief materials used in the States) will be so scarce and dear as to necessitate other means than grinding and leaching for extracting all the strength from the bark." It seems strange that when our American cousins are so ingeniously utilising what they consider their "waste" tan, that they are wasting* in a true sense from 7 to 10 per cent. of material.

* Chemists are now employed in all large American tanneries, and all materials much more thoroughly extracted under their direction.—Ed. *Fifth Edition.*

Leaching.—"The full and perfect extraction of all the tannin from the bark is not only desirable, but it is of primary importance; it is equally essential, however, that this subtle elixir should be extracted without deterioration or injury. It is found in practice not at all difficult to wash out all the extractive or soluble matter from the bark; but to separate and take out the greatest amount of tannin, leaving the largest portion of colouring and resinous matter behind, is quite a different matter, and one which has taxed the efforts of our best tanners. The system of leaching which will enable the tanner to control and separate these qualities is, in my judgment, the system to be most commended." In this view Mr. Schultz does not appear to be supported by some of the largest American tanners, as he frankly admits, but he believes that their theory is based on the assumption that colouring matter, entering into the substance of the hide, gives weight; and that also the resinous matter in some mysterious way attaches itself to the leather, defying the action of the scrubber to wash it off. To this theory he strongly objects, and asserts that "tannin, and not colouring or resinous matter, enters the fibre and gives weight." But if Davy's well-known theory be accepted, does not the colouring matter (setting aside the resinous matter) enter into the substance of the hide *with the vegetable extractive*, which forms an essential ingredient in the formation of leather?

The system of leaching in America, by the application of heat, appears to be open to objection, since the chief tanning agent, hemlock-bark, yields not only an objectionable colour, which is more freely extracted in hot than in cooler liquors, but also resinous matter, which can play no useful part in tanning. "The union-crop leather tanners," Mr. Schultz remarks, "have learned to appreciate the value of moderate instead of extreme heat, and when better methods of grinding and screening the bark shall be appreciated at their full value, then I assume that even less heat than at present will be employed by them, and the more nearly summer-heat (60°*) is adhered to, in the head leach,

* The summer-heat in this country is 78° Fahr.

the more modified and controllable will be the colour." Since it is so well known that tannin is freely soluble in cold water, and that colouring matter is more readily extracted from bark by hot than by cold water, it must certainly be erroneous, especially if the colouring matter is of an objectionable character, to use heat for the leaching of this otherwise most useful bark, hemlock. Mr. James Cleaver, an American tanner of repute, proved that he could make from 190 to 200 lbs. of leather with one ton of bark, never employing a higher temperature for his head leach than that of summer-heat, except in winter.

Of the several systems of leaching adopted in America, we may select the following:—

The "Press" Leach.—The number of leaches in a set (or round) should correspond with the number of days in the week. By this method one new leach is filled in each round every day in the week, but if more than one leach is required for the day's work, then the sets of leaches should be multiplied rather than disturb the order of the round. This arrangement gives at least five days for the leaching of all the bark, which is fully time enough. It is strongly recommended not to break the round, which only leads to confusion and waste. As to when and where heat may be applied, Schultz says, "Under no circumstances is heat to be applied to any other than the back or weakest leach. This will bring the strong liquor of the set on the head leach comparatively cold, or at most summer-heat. This course will take all the liquors in the yard in a proper condition to go upon the leather without coolers or waiting. It will leave behind much of the colouring and resinous matter, and send forward a pure tan liquor free from all sediment and impurities."

The *principle* on which the "press leach" works is thus described: "Warm water or liquor is more expanded, and consequently lighter than cold. Strong liquor is heavier than weak. Now if we put the two light conditions together, viz., hot and weak, and place them on top of the heavy and cold liquor, they will remain separate for all the time, or so long as these conditions are main-

tained. A simple experiment with water and tan liquor in a tumbler will demonstrate this practical result. Weak tan liquor will stand all day on the top of strong and heavy liquor, if not agitated. Now if to the weak liquor we add heat, the separation will be still more marked. A tumbler half filled with weak and warm liquor may be forced out of the top by gently inserting strong and cold liquor underneath by means of a pipe. The action of these bodies, if the experiment is carefully made, will satisfy any one that the system of press leaching can be carried on without mixing the liquors on their passage, if the system recommended be followed." In other words, it is a question of *gravity;* the heavier liquid, or that which is richest in tannin, will form the lower stratum, and the weak the upper stratum; and if strong cold liquor were introduced *from above*, through a funnel connected to a long tube, the end of which reached to the bottom of the vat, the weaker liquor would gradually rise to the surface.

In working the press leaches, each of the six leaches is filled at all times from two-thirds to three-fourths with bark, and stands covered with liquor varying in strength with the strength of bark in each. "Let us suppose," says Schultz, "that the head leach has just been filled with fresh-ground tan; the last or back leach is filled with spent tan ready to pitch, and the intermediate four leaches are divided into both, as to strength of liquor and age of bark, from these two points. No liquor is sent into the yard except from the top of the head leach, and where very strong liquors are needed, *only one liquor is so sent from each head leach*, so that the accumulated strength of all the bark in one leach is concentrated in this one liquor. If a less degree of strength is required, then two runs may be taken off, and in exceptional cases, even three or four. The liquor thus sent into the yard is not returned until the strength is taken from it, and it is either sent off into the stream as worthless, or sent back to the back leach, after passing through the heater, and heated up to 100° or 120°. I shall insist that the spent tan liquor,

which is accumulated acid (gallic), shall *go back* for sole leather, and shall *go off* into the stream if light leather, such as calf, kip, or even harness, is to be tanned."

The usual practice in working the leaches is to run the strongest and newest liquor direct from the leaches upon the head packs on the last layer. These liquors should stand at fully 30° by barkometer. After thirty days' use they will be reduced to 24°, a portion of which indicated strength will be "acid." Twenty days' further use on the third layer will reduce the strength to 18°, and so on until the liquors will be nearly exhausted and contain little else than acid. These liquors are put on the first layers, or run into the handlers to be more fully exhausted. The liquors are run from the leaches by covered and enclosed wooden tubes or bored-out logs. Mr. Schultz speaks strongly against the practice, even if accidental, of allowing warm liquors to come in contact with half-tanned or green hides which have been sweated, especially in warm weather, as decomposition and injury are sure to result.

Raising with Vitriol.—The practice of the American tanners with regard to the employment of sulphuric acid (oil of vitriol) for raising the pelt is variable. While some pass the sides through the handlers before introducing them into the acid liquor, others use the acid first and colour them afterwards; other tanners, again, add the acid to their handler liquors, by which they plump and colour the pelts at the same time, and when this method is adopted the strength of the liquor is renewed with sweet highly coloured liquor as each new pack is treated. Regarding the employment of sulphuric acid for this purpose, Mr. Schultz observes, "Vitriol-raised leather, when treated in the after process in weak liquors, produces a most unsatisfactory result. The grain is poor, the fibre coarse and 'hatty.' I do not here attempt to solve the mooted question whether vitriol does not destroy the tannin. It is conceded that it will plump and hold the fibre and will facilitate the tanning, but whether these advantages in an economical point of view are not more than counterbalanced by its destructive action on both

fibre and the tannin I shall leave for future experience to determine." He, however, concedes that vitriol "preserves the hides, and holds, when combined with salt, the gelatine from decay," and he moreover states that "all the green sheepskins that come from England to this country (America) in casks are preserved by this process, and may be so held without damage for years;" but he further observes that unless the acid in these skins is neutralised before they are put into tan liquor, they swell to more than double their wonted thickness, and will tear as easily as brown paper.

While Mr. Schultz allows that sulphuric acid raising may be adopted, without material damage, for hides which have been limed, he says, "In my judgment vitriol should never be used to raise purely sweat stock," in which, we imagine, none will differ from him; while it is equally clear that lime would be an appropriate steep for sweated stock.

Handling.—In America the system of handling by withdrawing the packs and allowing them to drain and then returning them to the handlers, as is usually practised in this country, or of working the handlers in *rounds*, have been substituted by mechanical appliances which reduce the labour of the workmen in this branch of the business to a minimum. The most generally adopted contrivances are the hand-reel (Fig. 43) and the "rocker." The former machine is placed in the alley-way between the pits to be shifted, and the hides to be transferred being tied together, are forced over from one pit to another by means of the revolving drum, which is turned by its handle by one man, while a second man adjusts the hides in the "head" pit. It takes only four minutes for two men to transfer 150 hides from one pit to another.

The Rocker Handler is a frame set in the top of pits, and is made of wood. The frame fills the pit within two inches of each end and one inch on each side, so that when it rocks from the centre it will play without touching (Fig. 44). It should be made of two-inch timber, and framed two by six inches. The end-pieces should be

made of hard wood not liable to split, since these have to bear the strain of the whole pack. The centre of this frame rests on pivots, supported by uprights from the bottom of the pits. A *stop* at each end of the pit prevents the rocker from dipping more than about eight inches. The hides are attached alternately by the head and tail to the end-pieces, with backs up and bellies down, by means of hard wooden pins permanently fastened in the head frame-pieces. Usually one end is fastened directly to or over the pin, and the other by an adjustable string which need not be more than a foot long, and may be made by a permanent slip knot to act continuously.

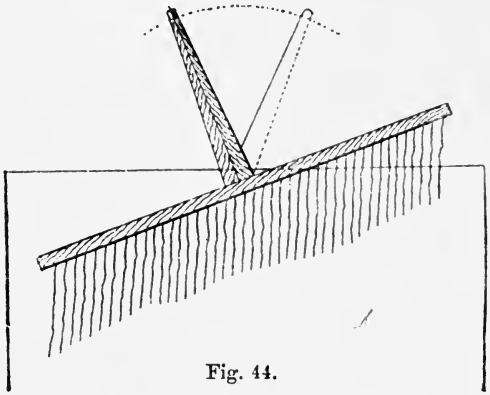

Fig. 44.

Sometimes "white spots" appear upon the surfaces of sweated hides after having been partially coloured in the handlers. These spots have been proved to be due to *grease* left by imperfect beam work, and the most approved remedy for this is caustic soda, a solution of which is rubbed over the spots, when they quickly disappear. This defect does not apply, of course, to *limed* goods.

The Layers.—Respecting the proper disposition of the hides in these pits, Schultz observes, "The question has often been raised whether the hides should be laid grain or flesh side up in the layers. The practice is to lay grain up, and this is justified on the ground that in

'hooking up' the grain is more apt to be scratched and marked than if laid flesh side up. If, as it seems quite likely, colour is seriously affected (particularly hemlock tannings), by the settling of the colouring matter on the grain, and a deeper, darker red is the result, then I think tanners may well inquire whether, in their attempts to avoid hook-marks, they do not entail upon their stock a worse evil. Besides, I will suggest in this connection whether it is not probable that tannin will enter the fibre of the hide more naturally from the flesh than from the grain surface. The pores of the hide, when on the animal, certainly do open their valves outwardly from the flesh, for all the emanations of the animal body go through these outward-opening valves or pores of the skin, and never receive back from the grain to the flesh." To this we may add, as a further suggestion, that while the tannin of the bark and ooze is being gradually absorbed by the hides, the liquor is kept in a continual state of imperceptible movement, by which the tendency of the exhausted liquid would always be *upward;* while the liquid renewed with tannin from the ground bark, being now heavier, would take its place, and thus a continual upward movement would result, as in the circulation of sap in a tree, though not of course with the same vigour.

CHAPTER XIX.

HEMLOCK TANNING.

Pratt's System of Tanning.—Hemlock Tanning of New Lebanon.—Hibberd's Process.

THE great success which attended the employment of hemlock-bark in some parts of the United States induced English tanners to turn their attention to this prolific source of tanning material, and during the past thirty years or so an extract of the bark has been imported from Canada in large and increasing quantities. The hemlock spruce-fir abounds in the northern states of Pennsylvania and Canada, and the readiness and cheapness with which the bark is obtained have rendered it the chief tanning material of those states, and a source of considerable industry in Canada. The extract comes over to this country in casks, of the consistence of treacle, and is of a dark brown colour. This extract is not soluble in cold water, owing to the large amount of resinous matter it contains, but it is freely dissolved in water at 150° Fahr. It may be employed alone, but owing to the indifferent colour it imparts to leather, it is generally used in combination with other tanning materials. According to Ramspacher, it yields 25 per cent. of tannin.

Pratt's System of Tanning.—The Hon. Zadock Pratt, who was one of the most skilful and experienced manufacturers of leather in the United States, furnished Dr. Morfit with some very elaborate and interesting particulars concerning his system of working, during a long series of years, at his famous tanneries at Prattsville, N.Y., from which we make the following interesting extracts :—

"Since I first commenced business, the gain in weight, in converting hides into leather, has been increased nearly 50 per cent. That is, from a quarter to a third more leather can now be obtained from a given quantity of hides than at the time when I learnt my trade at my father's tannery, conducted in the old-fashioned way. The great improvement in weight seems to have been gained by the judicious use of strong liquors or 'ooze,' obtained from finely-ground bark, and by skilful tanning. The loss and wastage upon hides, from hair, flesh, &c., may be estimated at from 12 to 15 per cent. In order to produce heavy weights, the hides should not be reduced too low in the beam house, and should be tanned quickly with good strong liquors, particularly in the latter stage of the operation. To green hides particularly, nothing can be more injurious than to suffer them to remain too long in weak ooze. They become too much reduced, grow soft, flat, and flabby, lose a portion of their gelatine, and refuse to 'plump up.' On the other hand, the effects of an early application of ooze that is too strong and too warm to green hides is very injurious. It contracts the surface and fibres of the skin, tanning at once the exterior layers so 'dead,' as it is termed, as to shut up the pores and prevent the tannin from penetrating the interior. This renders the leather harsh and brittle. It will be seen from this that, in the question of the proper strength of liquor alone, there is room for the exercise of the greatest judgment and the most extensive experience. In the impossibility of adapting fixed rules to the innumerable variety of cases, nothing can be depended upon but the judgment of the practical tanner.

"In softening hides and preparing them for the process of tanning, a great deal depends upon the judgment of the person superintending the operation, inasmuch as the diversities in the qualities and characteristics of the hides render it impossible to subject them to any more than a general mode of treatment. In 'sweating,' the character of the hides and the temperature are essential but ever-varying considerations. As a general rule, however, the

milder the process of preparing the hides for the bark the better. Unnecessarily severe or prolonged treatment is inevitably attended with loss of gelatine, and a consequent loss of weight and strength in the leather. Too high a temperature is particularly to be avoided. In almost every lot of hides, particularly Orinocos, however, there are generally some that prove very intractable, resisting all the ordinary modes of softening. For such, a solution of ashes, potash, or even common salt, will be found to be beneficial, and peculiarly so in hot weather. As I have said, no precise rule can be given as to the length of time required for the preliminary processes of soaking and 'sweating,' so much depending upon the qualities of the hides and the temperature at which these operations are conducted.

"The following table may, however, be found useful in conveying an approximation to a definite idea of the practice in my tannery:—

Soaking—

Temperature:	40° Days.	50° Days.	60° Days.	70° Days.
Buenos Ayres hides	10 to 12	8 to 12	6 to 8	3 to 6
Carthagena and Laguaira	8 „ 12	7 „ 9	5 „ 7	2 „ 3

Sweating—

Buenos Ayres hides	15 „ 20	12 „ 16	8 „ 12	2 „ 3
Carthagena and Laguaira	15 „ 20	10 „ 15	6 „ 8	2 „ 3

"I would here remark that I changed the process of liming to sweating in 1836—the only change in tanning I have made in twenty years; and for heavy sole leather it has been proved to be quite as good as liming, if not better, and somewhat cheaper, besides yielding a greater gain in weight, and, when well tanned, making leather more impervious to water. Liming and bating, however, for upper and light leather, is preferable, and if the same improvements had been adopted with the lime process of strong liquid and quick tanning, it is not yet certain that the same results would not have been attained.

"Salted hides do not require more than two-thirds the time to soak, but generally longer to sweat. After the

hides are prepared for tanning, the next process is what is commonly called 'handling,' which should be performed two or three times a day, in a weak ooze, until the grain is coloured. New liquors, or a mixture of new and old, are preferable for Spanish or dry hides, old liquors for slaughters. They are then, after a fortnight, laid away in bark, and changed once in two or four weeks, until tanned. Much care and judgment are necessary in proportioning the continually increasing strength of the liquors to the requirements of the leather in the different stages of the process. The liquors should also be kept as cool as possible, within certain limits, but ought never to exceed a temperature of 80°; in fact, a much lower temperature is the maximum point if the liquor is very strong, too high a heat, with a liquor too strongly charged with the tanning principle, being invariably injurious to the life and colour of the leather. From this it would seem that time is an essential element in the process of tanning, and that we cannot make up for the want of it by increasing the strength of liquor or raising the temperature at which the process is conducted, any more than we can fatten an ox or a horse by giving him more than he can eat.

"I have mentioned the injurious effects resulting from too strong a solution of the active principle of the bark; on the other hand, the use of too weak solutions is to be avoided. Hides that are treated with liquor below the proper strength become relaxed in their texture, and lose a portion of their gelatine; the leather necessarily loses in weight and compactness, and is much more porous and pervious to water. The warmer these weak solutions are applied the greater is the loss of gelatine. To ascertain whether a portion of weak liquor contains any gelatine in solution, it is only necessary to strain a little of it into a glass, and then add a small quantity of a stronger liquor. The excess of tannin in the strong, seizing upon the dissolved gelatine in the weak liquor, will combine with it and be precipitated in flakes of a dark curdled appearance to the bottom. At the Prattsville tannery the greatest strength

of liquor used for handling, as indicated by Pike's barkometer, is 16°; of that employed for laying away, the greatest strength varies from 30° to 45°.

"After the leather has been thoroughly tanned and rinsed or scrubbed by a brush, machine, or broom, it will tend very much to improve its colour and pliability to stack it up in piles and allow it to sweat until it becomes a little slippery from a kind of mucus that collects upon its surface. A little oil added at this stage of the process, or just before rolling, is found to be very useful. Great caution is necessary in the admission of air in drying when first hung up to dry. No more air than is sufficient to keep the sides from moulding should be allowed. Too much air—or, in other words, if dried too rapidly in a current of air—will injure the colour, giving a darker hue, and rendering the leather harsh and brittle. To insure that the thick parts, or butts, shall roll smooth and even with the rest of the piece, it is necessary that the leather should be partially dried before wetting down for rolling, and that when wet down it should lay long enough for every side to become equally damp throughout."

The average time for tanning by hemlock, in America, amounts to five months twenty-seven days; sole leather, however, occupies from four to six months, according to the strength of the liquor used and number of sides in the vats, and, according to Pratt, the quicker the tanning is effected the better is the result.

Hemlock Tanning of New Lebanon, N.J. — Dussauce gives the following description of the process of tanning with hemlock at the Shaker tannery of New Lebanon, as furnished to him by the Shaker tanner, Mr. Fred. Sizer. "I take a pack of calf skins—say 100 dry skins—and put them in a water vat to soak; after they have soaked two or three days I take them out and mill them (a wheel is best for milling hides); I then beam them on the flesh side, removing all the lean meat and grease from the skins, stretching them out well with the beaming-knife, and put these into a vat of clean water until they are soft enough to go into the lime. They must be as soft as

when they came from the animal, or as near that as you can get them. If the hides are not soft before going into the lime, they never can be, and the leather will always be hard.

"Fresh hides, that come direct from the butchers, are put in water a day or two; change the water once, beam them on the flesh side; they are then ready for the lime. I make my lime in a vat 8 feet long by 4 wide and 4 deep. One bushel of lime and 2 gallons of soft soap put in the vat two-thirds full of water will make a lime sufficient for 100 calf skins or five sides of upper leather. The hides should be handled out every other day, while in the lime, to air and change their position; then stir the lime well before they are put back. The lime needs strengthening every time a new pack is put in by adding, say half-a-bushel of lime and two or three quarts of soap. I lime my calf skins and upper leather hides until the hair comes off easily, but sole leather hides should be limed as little as possible to get the hair off; then unhair them, wash them out in the mill, beam them on the flesh side, trim off the pates and shanks, and put them in the bate.

"I put five or six bushels of hens' dung into a vat of the same dimensions as used for the lime and fill two-thirds full of water and let it stand two or three days to ferment. I let my skins remain in the bate two or three days in warm weather and longer in cold; haul them two or three times while in the bate, and work them twice on the grain with a common worker on the tanner's beam; mill them before working the last time, then beam them, and they are ready for the tan-vats. I make a liquor of moderate strength to handle them in, put them in this liquor, and stir them with a pole a while, then handle them up smooth on a box or rack three or four times in the course of the day; let them remain in this until the next morning, then change the liquor, giving them about the same strength as at first; handle them two or three times a day in the liquor, and when this is exhausted change again, and handle less as the skins get coloured and the grain set.

"I make my liquors of hemlock-bark, ground and put

in leaches, and pump in the exhausted liquor. The first strength of my leaches I draw off the sole leather vats. I draw off the leaches two or three times before taking it from my upper leather and calf skins, and these I keep in mild, sweet liquors through the whole tanning process. I handle my hides and calf skins through until tanned, changing the liquors as they get exhausted. After they get well along I handle them three times a week. They will do to lay longer, but will tan faster if handled often. When my calf skins have been in the tan two or three weeks I shave down the necks, and after my upper leather has been in four or five weeks I shave it down to a proper thickness.

"In my experience in tanning, which has extended through forty-two years, I have used both hemlock and oak bark, and I find that mild sweet liquors are far best for tanning all kinds of upper leather. The hide in the raw state is tougher than when tanned, and that toughness ought to be preserved as much as possible, to make good pliable leather, and the slow process of tanning with mild liquors will do it. Strong liquors have a tendency to make the leather hard and liable to crack. The hides for upper leather should not be tanned any more than thoroughly through; if tanned longer than this it has the same effect upon them as strong liquor; but the longer sole leather is tanned the better. When I think my leather is nearly struck through I try it by cutting into the thickest edge, and when tanned through take it up and scour it out on the wheel to cleanse it from the tan and soften the grain; then take them to the currying shop, and the calf skins I skive, and uppers smooth down with the currying knife; then put them in a tub of water and scour them on the table with a brush, stone, and slicker; dry them a little, temper them, and then put them on the table and set them on the grain side to work the grain out smooth. After that apply some thin stuffing made of oil and tallow, then turn them over, flesh side up, and set them out with an iron slicker; then apply the stuffing more plentifully, made thicker with more tallow;

then hang them on sticks and dry them, and then pack them down in a pile, and let them stay two weeks. I then take them and rub off what stuffing does not strike in, and whiten them with a currying knife or slicker. I commonly whiten my calf skin and kips with a slicker, and finish in the French style. Since the French dégras has come into use, I have used it for calf skins and kips. I have also for some time used tansy in my liquors. There is an acid in tan that injures the leather which tansy neutralises and keeps the liquor sweet."

Hibberd's Process.—This process consists—

First, in the use of a compound of lime, wood ashes, or potash, and salt for removing the hair or wool, and also for the purpose of so-called "liming," instead of using the lime alone. Lime and ashes have been used separately for the purpose of removing the hair, wool, &c., but lime alone requires several days, and in cold weather weeks, to effect these objects, by which, the inventor says, the skin is more or less injured. "On the other hand, ashes alone act too rapidly, and would destroy the skins altogether. When lime, ashes, and salt are combined in proper proportions, the salt modifies the action of the alkalies, and protects the skin from their caustic properties, so that the process of unhairing and liming are both rendered more expeditious and safe than by the old method, while the texture of the skin is uninjured, and consequently the leather is much stronger."

Second, in the use of a composition of salt, sulphuric acid and sumac, oak, hemlock-bark, or other tanning material for the process of tanning. The salt, sulphuric acid and tannin being mixed together in water in certain proportions hereafter mentioned, a portion of the salt is decomposed by the acid, forming sulphate of soda, and setting free *muriatic* acid, which acid, being absorbed by the water, acts directly and rapidly on the skins, opening their pores, and preparing them for the tannin, which, being present also in the mixture, immediately and readily unites with the gelatine of the skin, forming leather more expeditiously and perfectly than by the usual methods.

Preparation of the Skins.—By this process the skins may be prepared as usual, but the inventor prefers to employ the following, which he calls composition No. 1:—

Quicklime, fresh slaked	½ bushel.
Wood ashes	½ ,,
Common salt	3 pints.

For the ashes may be substituted from 3 lbs. to 5 lbs. of potash.

To remove the hair or wool, the above composition is to be mixed with sufficient water to make a thick paste, and applied to the flesh side of the hides in the usual way, the skins to be folded and kept at a temperature of summer-heat. In a few hours they will be ready to pull. For "liming" or "ashing," he uses the same composition, No. 1, mixed with a sufficient quantity of water in a vat to immerse the number of skins required to be treated. One bushel of the mixture is equivalent to one bushel of lime alone. The liming and ashing process may be conducted at a temperature of 40° to 60° Fahr.

Composition for Tanning.—For six dozen full-sized sheep, deer, goat, or similar skins of the same size:—

Common salt	18 lbs.
Sulphuric acid	2 ,,
Sicily sumac, or quercitron bark	36 ,,
Muriatic acid	2 ounces.
Dried clover	18 lbs.
Soft water	150 gallons.

The sumac or dyestuffs are first exhausted with water, and then the salt is added to the liquor, apportioned so as to ensure perfect solution. The acids are afterwards added, and the mixture thoroughly incorporated by stirring.

CHAPTER XX.

TANNING BY ELECTRICITY.

Ward's Process.—Gaulard's Process.—Gaulard's Second Process.—Meriten's Process.—Crosse's Process.

Tanning by Electricity.—Considering the many purposes to which the electric current has been applied, and the growing belief that this remarkable force is yet susceptible of many applications in the arts, it is not to be wondered at that endeavours should be made to utilise the current in the process of tanning. Whether success will attend the employment of electricity in the tannery has yet to be determined, and this, of course, can only be done by careful and unprejudiced trial. The time has come, we hope, when manufacturers cease to ignore new modes of procedure merely on the ground that they are novel.

Ward's Process.—The inventor states that the object of his invention is "the tanning of hides and skins by a more speedy and efficient process than heretofore, in suitably arranged vats or tanks, by the aid of electricity," and it is effected in the following manner: he employs the ordinary vats or tanks, which are lined with india-rubber cloth, or other non-conducting substance. The vats are filled with tan liquor, and the hides suspended therein. The electric current is obtained by means of a suitable battery. The effect of this, he states, is that the current passes through the whole contents of the vats, and the tanning process instantly commences, and continues until the strength of the liquor is absorbed, when, if desired, fresh liquor may be added, and the current again applied. By this means, the inventor states, hides

and skins "may be fully and effectually tanned in the space of a few hours."

Gaulard's Process.—The inventor says, "Various observations on the tanning of skins having demonstrated that the reaction produced has been the decomposition of the watery juice by the tannin, which seizes the oxygen, whilst the hydrogen acts on the nitrogenous matter and destroys it in changing it into ammoniacal salts, I have concluded that for causing a rapid tanning it suffices to

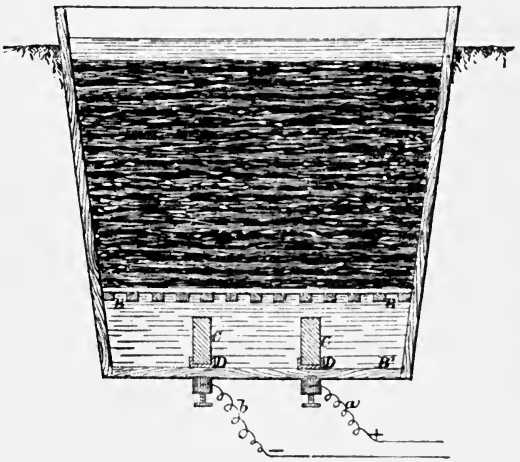

Fig. 45.

oxidise the tannin and destroy the nitrogenous matter by causing to intervene an electric current into the juice, which decomposes the water of the liquor into oxygen and hydrogen, and determines at the same time with rapidity the reaction above mentioned."

In carrying out the process the hides or skins are disposed as shown in the accompanying drawing. Fig. 45 is a tub A; on the upper floor B of the double bottom B B^1, the hides are stratified in the usual way, that is to say, with alternate layers of the hides or skins and tannin. In the space between the two floors of the double bottom B B^1

are placed two parallel charcoal blocks C C, fixed by the aid of copper clamps D D. The two charcoal blocks C C are put into communication by means of the wires *a* and *b* with the two poles of any electric generator, whereupon the decomposition of the watery juice into its two elements, oxygen and hydrogon, takes place, and the rapid assimilation of the tannin and the hides or skins is effected.

Gaulard's Second Process.—Referring to the former patent by the same inventor, the patentee says, "Instead of placing both poles [of the electric generator] in the

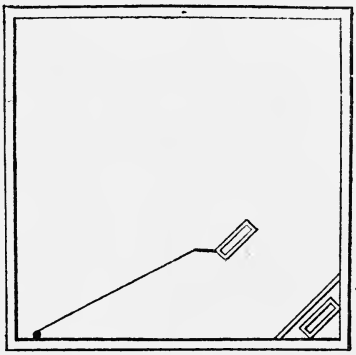

Fig. 46.

middle of the vessel, and thus causing the two gases evolved by the decomposition of the water [oxygen and hydrogen] to act simultaneously, one only of the electrodes is placed in the centre of the vessel, the other being arranged in a parallel plane, but in a corner, and in the centre of a passage or conduit, arranged as illustrated (see Fig. 46) in the drawing, that is to say, extending to about four inches from the bottom of the vessel. The vessel is filled with weak liquor, and the hides are suspended therein from wooden crossbars resting on the sides of the vessel. The electric current is then caused to pass in such a manner that the negative pole is in the centre of the vessel and the positive pole is in the 'conduit.' Under

these conditions the hydrogen alone acts upon the leather, and causes the rapid destruction of the nitrogenous matter contained therein. After undergoing this treatment for eight days, the liquor is changed for a stronger tanning solution. The current is then reversed, so that the pole in the middle of the vessel becomes the positive pole and the pole in the conduit the negative. The oxygen alone then acts upon the liquid, inducing a rapid oxidation of the tannin, and its precipitation in this condition in the cells formed by the gelatine and fibrine of

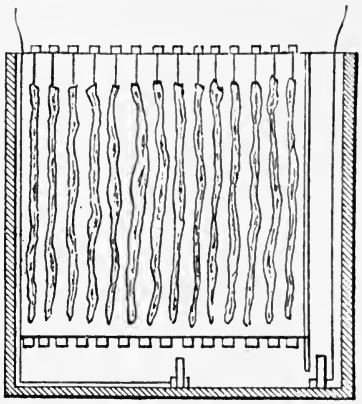

Fig. 47.

the hide. The hydrogen escapes into the air through the conduit. Under these conditions the tannin is effected in about fifteen days, and, in order to make the leather more weighty, a stronger liquor must be employed, or the hides may be stratified with layers of tan, as in the ordinary method, at the same time keeping up the electrical action. A wooden grating, arranged at a height of about eight inches from the bottom of the vessel, is employed to keep the electrodes from direct contact with the leather, as shown in the engraving, Fig. 47."

Meriten's Process.—The bottom of the tan-pit is composed of a block or slab of conducting carbon or char-

coal, or of two or more such blocks or slabs, covered with a layer of the same substance in a coarse powder. A copper wire coated with gutta-percha or other insulating material is employed, one end of which is connected to the carbon, and the other end, being carried up the side of the pit to the exterior, is connected to the positive pole of a battery. Upon the bottom so constructed, there is placed a layer of bark or other tanning material, sufficiently impregnated with water, and above this a hide or skin, then another layer of bark or other tanning material, then another hide, and so on in alternate succession to any required number. A sheet or plate of zinc, in connection with the negative pole of the battery, is disposed at the upper part of the pit, and rests upon a layer of the tanning material, and above the zinc there is placed a final layer of tanning material sufficiently impregnated with liquid as before. "On establishing an electric current, a motion takes place between the two poles through the hides or skins, the basic elements proceeding to the negative pole and the acid elements to the positive pole, whereby a molecular motion is produced and maintained throughout the hides or skins, and the fixing of tannin in their pores is effected. It is preferred to divide each of the poles into two or more surfaces, according to the depth of the pits and the quantity of hides which they contain; but it is in all cases essential that the *anode* (*positive pole*) should be composed of an insoluble material." This of course means carbon, or some metal not acted upon by the tanning liquor when decomposed by the current.

Crosse's Process.—This process has for its object *First*, the unhairing of hides and skins, by the employment of sulphide of lime, in which the hides are soaked, when the hair becomes loosened and may be removed in the usual way. *Second*, in producing electric effects on the matters in the tan-pit. On one side of the pit is placed a plate of lead, and on the other a plate of zinc, the plates covering the sides of the pit. The two plates are connected at the upper parts above the liquid by a band of either

metal. The skins are suspended in the pit, filled with water, and remain three or four days. The water is then removed or converted into ooze or tanning liquor, by adding bark or other suitable matter, or the water is replaced by tanning liquor of a strength equal to about 15° of a saccharometer, and the liquor is kept up at that strength for a week. The strength may be then increased to 5° a week till it reaches 45°. The process may be varied, and the strength and progressive increase of strength in the tanning liquor modified.

CHAPTER XXI.

CHEMICAL TANNING.

Knapp's Processes.—Heinzerling's Chrome Process.—Heinzerling's Second Chrome Process.—Vanderstraaten's Process.

We have been tempted to adopt the above heading to distinguish the processes about to be described from the ordinary processes of tanning, to which they may be said to have no resemblance. Whether the manufacture of leather by other agents than tannin will ever become really successful is a question which time alone can decide.* We know that alum and salt, as employed in the process of *tawing*, produce a certain effect upon the skins of smaller animals—as the calf, sheep, goat, &c.—which renders them suitable for certain purposes to which leather, properly so called, would be wholly unfit; but whether a substitute for tannic acid in the manufacture of leather from heavy hides will ever be discovered, is a matter upon which few will venture to prophesy "onless they know," as Artemus Ward put it. Many attempts have been made in this direction, and we may hazard the prediction that even if a better article could be produced without the agency of tannin, it would take a very long time before the world —so long accustomed to the smell of tan—would believe in it.

From the numerous processes which have been patented, we select several which have to some extent commanded attention, and at least one of which has been worked upon a practical scale: we allude to what is known as the chrome-tanned leather process of Dr. Heinzerling, carried out by the Eglinton Chemical Company, of Glasgow.

* The chrome process is now an acknowledged commercial success for most of the lighter kinds of upper leather, and is also used to some extent for harness and belting leather.—Ed. *Fifth Edition.*

Knapp's Processes.—I. By this process, which was patented in 1877, an oxide salt of iron is prepared in the following manner: To a boiling solution of green vitriol (sulphate of iron) as much nitric acid is added as will thoroughly oxidise the same. The effervescence which takes place being over, the operation is reversed, green vitriol being added to the solution now containing the iron oxide; the second ebullition or effervescence caused by this operation having subsided, the compound has now a syrupy consistence, and is of a yellow-red colour. If it be slowly evaporated, there remains the dry iron oxide salt as an orange-red transparent varnish. Basic sulphate of iron manufactured in this way is very different in its physical properties from that of commerce and described in chemical books. This latter does not give a syrupy solution, and is of a much darker colour—a brown-yellow—and decomposes on being boiled in an aqueous solution. On the other hand, the preparation above described may be boiled in a solution of 30° to 40° Baumé without decomposing, and is in reality copiously taken up by the skins of animals.

II. To carry out this process, the hides are treated with the above iron salt in the following way:—

First Dressing.—To prepare the hides, they are placed in a cold solution of the iron oxide salt, and the dressing is thus completed in two, or at the most four, days, according to the quantity of skins or hides treated at once. Relaying the skins, handling, and other like operations are dispensed with.

Currying.—After the skins have been tanned(!) with the iron salt solution, they are treated with fats and greases in a liquid state, and with a new "iron soap" described further on. The greases are dissolved in the manner now in use, and the leather soaked with them, or "stuffed," after the skins have been sufficiently dried. In this manner the present expensive and tedious hand manipulation, which makes the value of leather so dependent on the skill and attention of the workmen, is quite done away with; that is to say, the greasing of the leather by hand

with greases, fat, and like substances, the hanging up in the drying-room, the tramping in the drum, and the working off of the superabundant greases, is thus done away with. Besides the greases now in use, the inventor employs stearine and paraffin, which are chemically dissolved in the usual way. By the use of fats in combination with the iron solution, the substances used for greasing the leather are united in such a way on the fibres of the skin as to form an "iron soap," which is an entirely new product.

The iron soap is produced by precipitating soap from its solution by means of the afore-mentioned iron salt solution. The iron soap, combined or not with fatty emulsions, is worked into the leather by means of a drum. This drum consists of a tramping drum, which revolves round a hollow axle, this latter being connected with a blower by a pipe. The blower drives the air through the hollow axle, and through pipes to the circumference of the tramping drum, and through the hides.

III. In this process a solution of sulphate of peroxide of iron is produced, which acts in the same manner as the solution before described, but with better effect in tanning. Moreover, it is chemically a different compound. This solution is produced by adding equivalent quantities of sulphuric acid and nitrate of soda, instead of nitric acid, to the boiling solution of the sulphate of iron. With the exception of these substitutions, this solution is to be treated in the same way as before. The solution differs from the former chiefly by the soda of the nitrate of soda entering into the new compound as a constituent part, along with the peroxide of iron and the sulphuric acid.

IV. In this process the inventor treats the leather with albuminous matters, as blood, &c., in such a way that they form a precipitate and compound with the peroxide of iron of the "tanning" salt before described.

Heinzerling's Chrome Process.—The hides are unhaired and soaked in the usual way, after which they are placed in a solution of from 1 to 5 per cent. of acid or neutral chromate of potash, chromate of soda, or chromate

of magnesia, and from 1 to 10 per cent. of alum, or a corresponding quantity of sulphate of alumina. To these may be added from 1 to 10 per cent. of chloride of sodium (common salt). In this bath the skins are left a longer or shorter time, according to their texture and thickness. After the hides have been in the solution for some days, a small percentage of yellow or red prussiate of potash is added, or may be introduced at the commencement of the operation. The prussiate of potash is preferably used for leather which is afterwards to be blackened, and may be dispensed with for other leather. In order to fix the tanning (!) stuffs in the leather, manipulated as above described, the hides should be placed for a short time in a solution consisting of 1 or 2 per cent. of chloride of barium, 1 or 2 per cent. of acetate of lead, or the same proportion of soap. The hides can be dried in the usual manner.

The smooth, damp hides are next dipped for a short time in stearine, paraffin, chrysene or naphthaline, resin, or other like stuffs, the same having been dissolved in benzine, photogen, or other like solvents. To the above may be added some carbolic acid or thyme oil. The greasing can be effected as usual. The new leather is said to be practically watertight, and when required, is made much softer and more lasting than ordinary leather, while the cost is stated to be much lower than by the bark process.

Heinzerling's Second Chrome Process.—In this process the inventor employs other chrome compounds than those mentioned in the preceding process, as also certain other substances which he has found to be effective in preparing leather by his method. He says, "I have found, too, in experimenting, that there are many chrome compounds besides chromate of potash or magnesia that are effective. Thus, chromic acid, the other soluble chromates, especially those of ammonium, aluminium, and iron, or the sulphate, chloride, acetate, and other soluble chromium salts, are all efficacious for the purpose of converting skins or hides into leather. I also find that the precipitation of soft white neutral mineral material in the pores of the

leather is very advantageous in preserving it, improving its colour, and making it impervious to moisture. Further, that the addition of such salts or oxides as the sulphates of copper, manganese, and zinc, chloride and borate of zinc, tungstate of sodium or of potassium, sulphate or chloride of protoxide or sesquioxide of iron, and oxide of manganese, improve the texture, durability, and colour of the leather." The inventor then gives the process as actually practised by him in Germany, and which is, we presume, the same as that which has been adopted by the Eglinton Chemical Company, of Glasgow.

"The hides being unhaired in the usual manner, I put them first in a weak, and after a few days in a stronger solution of a soluble chromate or chromic acid. To this solution I add a soluble salt of aluminium, or the soluble hydrated oxide which is formed when carbonate of soda is added to a solution of alum. The quantity of aluminous matter in solution depends on the texture of the hides, the density of leather required, and the salts used; it varies, therefore, from nothing to say four parts by weight of oxide of aluminium to one hundred of water. The quantity of chromium salt used varies from half to five parts to one hundred of water. In the first pit both the chromic and aluminous materials are weak, especially the latter. While in succeeding pits the chrome does not vary much, that of the aluminous matter varies widely, sole and other hard leathers requiring large quantities, whereas washleather and thin uppers require none, or very little. During the cold season the pits can be moderately heated, say 30° C. (86° Fahr.) The hides are left in this chrome and aluminous solution, with or without the addition of any of the above-mentioned metallic salts useful for improving the colour or for tanning, from one to twenty days, according to size, texture, and thickness of the hides, until they are perfectly converted. Their progress and complete conversion may be easily tested by cutting off a piece and seeing if the tanning liquor has thoroughly penetrated it. After this they are put into a solution of, say from three to eight per cent. of a soluble carbonate,

such as carbonate of sodium or potassium, or a solution of soluble soap, say three to six per cent., in order to fix superficially the tanning materials. In some cases it is advantageous to use, instead of the above bath, a soluble barium salt, such as the chloride, especially when alum or other sulphates have been largely used.

"Instead of treating the hides with carbonate of sodium or soap in solution, as before mentioned, in some cases it may be advantageous to use albuminous matter, such as the serum of blood, either dissolved in acids or alkalies, or in the solid state, finely divided, as it is used in the kid leather manufactories. The hides are either immersed for a certain time till the matter has entered superficially, if a solution be used, or tramped in a tramping tun for an hour, in order to facilitate the mechanical entering of the albuminous matter.

"The hides intended for upper or belt leather are now dried till they are merely damp, and then stretched; those for sole leather are made quite dry. They are then put into a solution of paraffin, stearine, colophony, or the like (dissolved in any suitable solvent, such as benzole or photogen), or into vegetable or animal wax, or such stuff as that formed from treating rape or linseed oil with ten to eighteen per cent. of chloride of sulphur, or the solid soluble residues which are obtained in petroleum and paraffin refineries, or varnish and birch-tar oil; the above solution is heated from 26° to 38° C. (about 76° to 100° F.) in a water-bath before and whilst the hides are in. The hides are kept in this bath preferably at from 28° to 30° C. (about 86° F.) for from one to three days, according to size, texture, and thickness; they are then exposed to the light for twenty-five to sixty days, until the stearine, paraffin, colophony, or other hydro-carbon used appears oxidised throughout Upper and belt leather can be greased a second time if required with the usual substances or with vaseline. The above-described stuffs may be also used in the melted state if they are fusible at a low temperature.

"After a certain quantity of hides have been tanned, it

will be found advantageous, instead of adding soluble aluminous salts, to add a quantity (proportional to the acids set free) of basic aluminium compounds got by incomplete precipitation of aluminium salts with carbonate of sodium or ammonium, or of hydrate of alumina. The tanning liquor should be analysed from time to time, and the mixture kept up to standard chemical composition."

Vanderstraaten's Process.—The following is a brief outline of the process, the inventor being a Belgian tanner:—The hides, after being cleansed from all materials incidental to the removal of the hair, are put into a bath of vegetable tannin of a certain strength, which prepares them for the succeeding treatment. The bath is made from valonia or similar vegetable substances, and if twelve hides are to be treated at one operation, in a vat holding about six cubic metres, five kilogrammes of valonia are required. This is first boiled in order to extract all the tannin. The hides remain in this bath one day, and another day in a second bath, which is made a little stronger than the first. The baths can be used over again by adding fresh material until they are of the desired strength. This first tanning gives to the leather an iron-grey colour. The second operation is performed by means of bichromate of potash, which turns the iron-grey colour into a mahogany-brown. If a lighter shade is desired, half the valonia of the first process is replaced by a corresponding quantity of mimosa-bark. The colour of the leather can thus be determined at the will of the tanner by varying the quantity of tanning material, the strength of the mixture, and the time consumed in the operation. The hides, which are so far only superficially tanned, are then immersed in a solution of either alum, sulphate of silicon, chromate of potash, salts of iron, or other similar astringent agents.

The inventor claims no right to any of the tanning processes by minerals, but confines himself to the following, preferring the use of bichromate of potash; the hides are immersed in a weak solution of this salt, and frequently taken out and turned, so that the chemical action which

produces the grain and colour may be uniform. For this purpose one or two hours are generally sufficient. If the operation is successful, a fine grain, soft to the touch, is formed, and a moderate swelling can be seen. The colour becomes permanent, and can no longer be changed. In the first weak bath they are suspended and subjected to a gentle motion; here they remain until the tanning material has thoroughly penetrated the skin, which generally occurs after from twelve to fifteen days. The hides are then taken out, thoroughly washed, and subjected to strong hydraulic pressure, by which means most of the chrome liquor is forced out of the leather, while some of it remains, and this has to be rendered insoluble, which is done by a gelatine treatment. The hides, as soon as they leave the press, are dipped into a bath of hot gelatine, made from the offal of fresh leather, until they are thoroughly impregnated with it, and after this are placed in an agitator for about an hour, by which time the gelatine will have been absorbed by the leather. This treatment renders both the bichromate of potash and the gelatine insoluble, and strengthens the leather by replacing the natural gelatine which had been extracted in the earlier operations of the process.

CHAPTER XXII.

MISCELLANEOUS PROCESSES.

Indian Method of Preparing Elk-skins.—Old Irish Process of Tanning.—Tanning Nets, Sails, and Cordage.—Glycerine in Tanning.—Bleaching Leather.

Indian Method of Preparing Elk-skins.—Immediately after the skin is removed from the animal it is spread out to dry. The brains are then removed and also dried in the sun upon the grass. When the hunting season is over, the women prepare the hides by soaking them first in water, and afterwards taking off the hair with an old knife. The hides are then put into a large earthenware vessel containing water, and the brains are then added and the vessel heated to about 95°, by which operation they become very well cleansed. The skins are next wrung out and spread upon a kind of rack formed of two upright posts, with two sticks placed horizontally. With the assistance of ropes, the women spread them very well, and during the drying they rub them continually with a stone or round piece of wood, to assist in getting rid of the water and grease, till they are quite dry. In one day a woman can prepare from eight to ten skins.

Old Irish Process of Tanning.—This consisted in utilising the *heath*, which grows abundantly in Ireland, as a tanning material. The heath was put into a large cauldron full of water and allowed to boil for about three hours, by which time the tanning principle was exhausted. The liquor was afterwards drawn off into large vats and

the material again treated with water as before. When this last liquor had cooled down to about 95°, the skins were first immersed in this, and afterwards in liquor of increasing strength. In using the liquors the temperature should not exceed 95°. A very good leather was produced by this process.

Tanning Nets, Sails, and Cordage.—The following method of preserving and increasing the strength of nets, sails, and cordage was patented many years ago. A hundred pounds of oak branches and the same quantity of tan are boiled in eighty-nine gallons of water, until it is reduced to seventy-one gallons. The solid materials are then taken out, and the articles to be tanned are deposited in the liquid, care being taken that they are entirely covered by it, and do not rest upon the bottom of the vessel. They are boiled for three hours, and are then taken out and dried. This, though a true tanning process, can scarcely be likened to the ordinary ones for preparing leather, since its object is a combination of tannin and extractive matter with vegetable substances, which are very different from the gelatine of skin. According to Millet, linen which had been steeped in an oak-bark liquor at 150° Fahr. for two or three days, remained unaltered in a damp cellar for ten years, while an untanned piece entirely rotted under similar circumstances.

Glycerine in Tanning.—M. Méne, after first observing that glycerine is a substance which has been found by experience to be useful as a means of increasing the elasticity and strength of leather, states that hides, first partly tanned by the usual process, may be greatly improved, especially if required for machine belts, by being soaked for some time in glycerine.

Bleaching Leather.—One might naturally think that when leather possesses all the characteristics of solidity, firmness, and toughness, being perfectly tanned throughout its entire substance, that its colour would be a matter of little concern. That this is not so, however, is well known, and any divergence from the *tan colour* proper

is sure to create a prejudice against the leather, be it ever so good in all other qualities. This is specially so in the case of hemlock-tanned leather, which, unless prepared with more than ordinary care, or combined with other tanning materials to reduce its natural redness, presents a colour which, in the eyes of those accustomed to the colour of oak-tanned leather, is objectionable in the extreme. To overcome this well-known prejudice against hemlock tannage, many ingenious persons have turned their attention, with the result that certain *bleaching processes* have been introduced into the United States, for the details of which we are indebted to Mr. Jackson Schultz, who, however, does not commend this system of tampering with leather in the processes of finishing.

By one process of bleaching sugar of lead and sulphuric acid are employed. "The practice is to dip the sides alternately, first into the bath of the one and then into the other, until the colouring matter of the hemlock is fully removed. This bleaching process gives an immediate, that is almost magical, result; but when the finished leather is exposed to the air and light for any considerable time, the delicate pink and cream colour turns to a 'murky brown,' and is in all respects a most objectionable finish. The only natural and honest bleaching process known to the writer is that of 'sumac baths.' After the hemlock sides have been cleansed of all extraneous matter by the most effective mechanical device known, they must then be hung in a vat of warm sumac liquor, and plunged frequently for one day—even a few hours will sensibly affect the colour. Usually one bag of Virginia sumac will suffice for a pack of one hundred sides. This process will cost about five dollars for a pack, or five cents per side weighing 15 lbs. to 20 lbs. The sumac liquor forms a vegetable acid, which acts most kindly on the grain of hemlock slaughter leather, not only removing (neutralising) the colour, but softening the grain, and contributes very much to the whiteness and clearness of the buff." Mr. Schultz says that hemlock leather thus treated will

retain the improved colour for a long time, and "never go back to that muddy and objectionable colour so common with other bleaching processes."

"As it is the acid which effects the object sought," Mr. Schultz observes, "the sumac should be retained long after the tannin has departed. As a mere tanning agent it is only valuable, as all goat and sheep skin tanners comprehend, while it is fresh, and before the acid forms. But for the purpose of bleaching hemlock leather it is questionable whether the old cast-off sumac of the morocco dresser is not quite as valuable as new sumac." To this Mr. Schultz adds an important suggestion which the users of hemlock will doubtless appreciate. "Slaughter hemlock leather, tanned with liquors of moderate strength, say 16° to 20°, will produce a colour that is between the lemon and the orange, and if to this we add the warm sumac process, we have then a colour so nearly a light lemon or flesh colour as to meet all the requirements of the best oak. . . . . This process is particularly serviceable on calf and all grain-finished leathers, including harness and bridle. No hemlock tannages will 'take the bleaching' so well without as with this process. With it grain leather can be made to hold its colour almost equal to a pure oak tannage."

NOTE.—Sumac is still used extensively for bleaching purposes. Care must, however, be used in its application, otherwise the leather so treated is likely to lose weight. Sumac appears to possess the property of being able to dissolve and withdraw some of the more solid constituents of the previous tannins used.—ED. *Fifth Edition.*

CHAPTER XXIII.

ON THE COST OF AMERICAN TANNING.

Mr. J. Schultz on the Cost of Tanning.—This observant American authority has entered very fully into the question of the cost of tanning, and with his usual clearness of reasoning has shown how variable may be the results obtained by manufacturers working under different conditions or by different methods of tanning. He approximately estimates the cost of tanning as follows:—

Hemlock sweat sole leather	per lb.	from	6	to 7	cents.
Union lime sole leather	„	„	8	„ 9	„
Oak lime leather.....	„	„	9	„ 10	„
Oak lime rough leather.....	„	„	8	„ 9	„
Hemlock lime rough leather....	„	„	6	„ 7	„

The cost will differ with the circumstances under which the tanning is conducted. One tanner devotes extra time to the beam work; another to the finishing; another to the handlers or layers; the freight and price of bark will vary in different localities, therefore in estimating the cost it is to be understood that an average is given.

One ton (2,240 lbs.) of average hemlock bark will tan 200 lbs. of sole leather, with the following exceptions:—1. If the bark is ground and leached imperfectly, or in an extraordinarily perfect manner; 2. If the leather is tanned with a very strong decoction, and thereby a very large gain is obtained as against very weak liquors and light gain; 3. Great delays and wastes in applying the tannin, which induce the formation of gallic acid; or the

bringing fresh, sweet, strong decoctions into contact with liquor already containing a large percentage of this acid. These exceptions will vary the result from 180 lbs. to 200 lbs. of leather made from one ton of bark. Again, if the *weight* of the delivered bark is not accurate a loss will accrue from this cause.

Mr. Schultz attaches great importance to the strength of the liquors employed, as influencing the cost of tanning. He says: "The upper leather tanners of New England, who pay ten to twelve dollars per cord [or ton] for their bark, claim to tan, and probably do tan, from 300 lbs. to 400 lbs. of upper leather with 2,240 lbs. of bark. If we comprehend how this is possible, it will enlighten us as to the point under discussion. The upper leather tanners draw their tanning and colour matter from agents which furnish about 20 per cent. extractive material, while the vigorous sole leather tanner obtains his capital from the 7 to 8 per cent. tannin which the bark contains. The tannin gives all the gain added to the gelatine, but the colouring matter permeates the fibre, while cumulative gallic acid holds it from decomposition. Upper leather, then, is not tanned and filled as sole leather is, and to this extent and for this reason bark extract will spread itself over far more fibre when all the extractive matter is employed than when it is manufactured so as to hold only tannin pure and simple. It must be evident that when skins are tanned quickly in strong liquors it is at the expense of the most costly agent (the tannin), while the vegetable extractive (the cheaper material) does not enter the skin to any appreciable extent. Consequently, if we are to accept Davy's view, the leather produced, while being extravagantly filled with tannin, will be deficient in one of its most important constituents (extractive), and therefore inferior in quality and of less value than leather which is tanned by slower methods. . . . . If upper leather and calf skins are to be sold by the pound (waiving the question of quality, especially toughness), then it is evident that these light tannages cannot be afforded. But if sold by measure, then a light

tannage is profitable to both tanner and consumer under proper circumstances."

The above observations are introduced to solve the question whether a sole leather tanner who tans by the pound can afford to make heavy gains for his employer. One tanner makes 160 lbs. and another 170 lbs. of leather from 100 lbs. of hides, "Are they," asks Mr. Schultz, "entitled to the same pay per pound? Is the cost to each proportionate? The argument on the one side is as follows:— It costs a certain sum to work in, handle, and finish a given lot of leather, whether of heavy or light tannage; the cost of the bark being alone considered, it cannot exceed, and most usually falls short of, the price received for tanning, even though the price be as low as six cents per pound. The sole leather problem is then, in fact, but the upper leather question over again, which would ask and determine the following: Can a customer afford to tan rough leather for less per pound than sole leather, less the finishing?" He does not consider it an answer to say that they do tan it for less, or that small tan-yards, without much interest to pay, pursue the trade successfully, while the argument on the other side is that "heavy gains cannot be made with strong decoctions; strong liquor cannot be obtained unless more or less waste is permitted— waste in the liquor itself, and more strength lost in leaching. Besides, the actual net added weight costs more than is received, which is calculated as follows:—

Original weight of hide.....	100 lbs.
Less hair, grease, fat, &c.....	15 ,,
Net gelatine and animal fibre	85 lbs.

"Now, whether this product is raised to 160 lbs. or 175 lbs. is a question of mere intrinsic cost of the pure tannin, *which is capable of combining with the gelatine.* In the one case 75 lbs. is required, and in the other 90 lbs. The cost of these respective factors made from bark at six dollars per cord would be (on the theory on which we are proceeding) fully eight cents per pound, since in both cases we start with the hide capital of 85 lbs. It may be

assumed that there is a discrepancy between the theoretical and practical percentage of tannin obtainable from bark. We know that 2,240 lbs. of hemlock bark will make only 200 lbs. of leather. Chemists tell us, however, that there is 8 per cent. of tannin in this bark, consequently there is in this ton of bark 156 80-100 lbs., which, combined with 85 lbs. of gelatine, should give 241 80-100 lbs. of leather [without reckoning the vegetable extractive ?]. What has become of this 71 lbs. of lost tannin?"

May we not venture to suggest that while a considerable proportion of the lost tannin is converted into gallic acid, a further portion is exhausted (especially when the liquors are made with hot water) by combining with the fibre of the bark—tanning it, in fact ?

Mr. Schultz gives the following as the probable cost of each item in the production of hemlock leather :—

Cost of bark (hemlock) per lb	3 cents.
Cost of soaking, milling, sweating and beam work	1 cent.
Yard work, including handling, laying away, &c	½ ,,
Finishing, including drying, rolling, &c	½ ,,
Insurance, interest on tanning and bark	½ ,,
Freight to and from the market	1 ,,
Administration	½ ,,
Total	7 cents.

CHAPTER XXIV.

MANUFACTURE OF LIGHT LEATHERS.

Russia Leather.—Count Kartstoff's Description of Russia Leather Manufacture.—Smoking Skins.—Another Method of Preparing Russia Leather.—Black Russia Leather.—Yufts Russia Leather.—Morocco Leather.—Sumao Tanning.—Imitation Morocco Leather.—Skiver.—Cordovan Leather.—Roan.—Hungary Leather.—Wallachia Leather.—Barley Dressing.—Morfit's Remarks on White Dressing.—Red Dressing.—Bran Dressing.—Enamelled Leather.

Russia Leather.—The peculiar characteristics of this famous leather have won for it almost universal admiration. Its agreeable perfume, which, like the Tonquin bean, it communicates to other objects placed in contact with it; its resistance to damp, which fails to produce that mouldiness or vegetable growth to which most leathers are subject under such conditions; and the well-known fact that insects are repelled even by its odour, have combined to maintain the popularity of this agreeable leather. Although it is generally understood that the true secret of its manufacture has been jealously guarded by those whose interest it is to keep it from the public, the process, more or less accurate, has from time to time been made known by various writers. The process, as given by Ure,* is as follows:—

"The skins are freed from the hair or fleece by steeping in an ash ley too weak to act upon the animal fibres. They are then rinsed, fulled for a longer or shorter time, according to their nature, and fermented in a proper steep, after having been washed in hot

* "Dictionary of Arts, Manufactures," &c.

water. They are taken out at the end of a week; but they may be steeped a second time, if deemed necessary, to open their pores. They are now cleaned by working them at the horse [or beam] on both flesh and grain sides. A paste is next composed, for 200 skins, of 38 lbs. of rye-flour, which is set to ferment with leaven. This dough is worked up with a sufficient quantity of water to form a bath for the skins, in which they are soaked for forty-eight hours; they are then transferred to small tubs, where they remain during fifteen days, after which they are washed at the river. These operations serve to prepare the skins for absorbing the astringent juices with uniformity. A decoction of willow-bark (*Salix cinerea* and *S. caprea*) being made, the skins are immersed in the boiler whenever the temperature of the liquor is sufficiently lowered not to injure the animal fibres, and handled and pressed for half-an-hour. The manipulation is repeated twice daily during the period of a week. The tanning infusion is then renewed, and applied to the same skins for another week, after which, being exposed to the air to dry, they are ready for being dyed, and then curried with the empyreumatic oil of the bark of the birch-tree. To this substance the Russia leather owes its peculiarities. The skins imbibe this oil most equally before they are fully dry. Care must be taken not to apply too much of it, for fear of its passing through and staining the grain side of the leather." The red colour of Russia leather is supposed to be produced by Saunders-wood or Brazil-wood.

Count Kartstoff's Description of Russia Leather Manufacture.—In a memoir published by Count Kartstoff, the following description of Russia leather tanning is given:—"The dried skins are softened by soaking in water for five or six days in summer and ten or twelve days in winter, and, after being well cleaned, are deprived of hair by steeping in milk of lime—185 lbs. being mixed with water in a vat eight feet in diameter and seven feet eight inches high. The skins are frequently examined, and when the epidermis and hairs *give* readily,

they are carefully unhaired upon the beam and then fleshed. Stout hides are not limed, but exposed in a sweating-room, piled upon each other, and sprinkled with salt to prevent decomposition; bran baths are used for the same purpose for thin and delicate skins. The skins, after being limed, are well soaked, washed, beaten out with the feet, and rinsed in warm water until the last portions of the lime have been removed from them; they are then *raised* by steeping for forty-eight hours or more in a vat of the above dimensions, containing a fermented mixture of warm water with 1,100 lbs. of ryemeal, or 450 lbs. of oatmeal, 6 lbs. of salt, and a sufficient quantity of leaven. Being thus prepared for tanning, they are steeped for a time in a weak infusion of oak or willow bark, the latter being preferred, and are then stratified in a vat with layers of coarse bark, the vat being filled up with the tanning infusion first used, and its contents being pressed down with planks, heavily weighted with stones.

"The skins are left in this vat from fifteen to twenty-eight days, after which they are removed and again stratified with fresh bark. This operation is repeated from three to six times, according to the nature and quality of the skins, the thinnest kinds only requiring two changes. The stiffness acquired by the leather in tanning is then corrected by soaking them for a day or two in a paste composed of—for every 150 skins of ordinary size—130 lbs. of oatmeal and 9 lbs. of salt, mixed with warm water. The leather is then well washed, rinsed, and drained, and, while in a partially moist state, is placed upon a large table, flesh side up, and coated with oil. This is composed of a mixture of the oil obtained from sea-calves (which abound in the Caspian Sea) and of the pure oil or tar of birch-bark in varied proportions, according to the nature and quality of the leather, one part of the latter to two parts of the former being generally used. The workman spreads the mixture with his hand evenly and uniformly over the surface, and the perfection of this operation depends upon the

skill with which it is done. About nine ounces of oil are applied to each skin of medium size. When oiled, the leather is then stretched out upon cords in an open shed until perfectly dry, and in the winter season is exposed to the cold air, by which its appearance is much improved."

Smoking Skins.—The Baskirs and Kerguises prepare their skins by smoking in lieu of tanning them. They first stretch them out, in their green state, between stakes fixed in the ground, and then remove the hair by scraping with a broken sickle fixed in a wooden handle. They then dig a pit in the ground, proportioned in size to the number of skins to be operated upon, and suspend them across parallel cords which are attached to its edges. A round hole is then dug five feet from the edge of the pit, and is connected with it by a subterranean gutter. The skins are hung upon the cords, the pit is covered over, and a fire of dry rotten wood is lighted in the small hole, the top of which is then closed. The smoke then passes through the connecting gutter into the pit, and the skins are kept exposed to its action for two or three weeks, at the end of which time they are found to have acquired properties similar to those of leather, and, above all, a degree of impermeability which does not exist in that which is tanned.*

Another Method of Preparing Russia Leather.—This method, described by Venables, is carried out as follows:—The whitest and most perfect skins being selected, are first soaked in water, then scraped upon the beam, fulled, worked with the pommel, and then oiled upon the *hair side* with pure fish-oil, and upon the *flesh side* with a mixture of oil and train-oil scourings. When dry they are again pommeled, washed over upon the hair side with a solution of alum, and then pressed under the cylinder. This cylinder, by which the diamond-shaped grain is given to Russia leather, is made of steel; it is

* It is more than probable that this primitive method of *curing* skins was practised in the earliest ages, many centuries before the tanning properties of plants were known.—A. W.

about twelve and a half inches long and three inches in diameter, and is covered with a number of close parallel threads or grooves, like those of a screw, but cut perpendicular to its axis, and not spirally. The cylinder is filled with stones, and is moved in two directions upon a wooden bench or support by means of a cord passing round a wooden roller with a handle. This cord passes also over two cylinders attached to the floor and a fourth one upon the edge of the bench. The cylinder having the handle upon its axle is divided into two different parts, over which the two extremities of the cord pass in different directions, so that two opposite movements can be given to the cylinder by one handle.

The cylinder is sustained and directed by iron bars placed along the bench upon which it rolls. The skin which is to be grained is placed below it lengthwise upon the bench, and longitudinal grooves are pressed upon its surface by the track of the cylinder. The skin is then removed, and again placed upon the bench, either crosswise or at an angle, according as it is intended to give it a square or a diamond-shaped grain. When properly grained, a second soak of alum-water is applied, and when nearly dry the *Russian oil* is spread over the grain side, and the red or black colour is given. The skin is then repeatedly exposed for a short time to the direct rays of a hot sun, until the colour has sufficiently penetrated its substance, when it is fulled, pommeled, sleeked with the round knife, upon the beam, and finally, well rubbed upon the hair side with a hard brush. The chief characteristic of the preparation of Russia leather is its impregnation with the birch-bark oil, the mode of preparing which is still, in a measure, kept secret. In order that the oil should penetrate the leather properly, the latter must not be either too moist or too dry, but should contain just sufficient water to enable the oil to spread equally over the surface, and be absorbed in proportion as the moisture gradually evaporates. Thus prepared, the leather retains the characteristic odour for a long time. Great care should be taken not to apply an excess of the oil.

From 12 ozs. to 1 lb. generally suffice for fully impregnating a large cow-skin. In the case of leather not dyed, or of Morocco to which it may be desired to impart the odour, only a very small portion should be applied to the flesh side. The composition of the red colour with which Russia leather is commonly stained has not been accurately ascertained. It usually contains Brazil-wood, alum, and some other ingredients. It is not very durable,* and does not resist the action of boiling water or of potassa, though it generally remains unaltered in the air. Other dyes of better quality are sometimes used, which enhance the price of the leather.

Black Russia Leather is prepared in the same way as the other, and is stained by repeated applications of the acetate of iron.

Yufts, or Youfts Russia Leather.—Wagner describes the method of preparing this leather, the name of which is derived from the Russian word *yufte*, signifying *a pair*, because, as it is supposed, the hides are sewn together in pairs previous to the process of tanning. The hides usually prepared for leather in Russia are those of young cattle; sometimes, however, the hides of horses and skins of sheep, goats, and calves are employed. The operations for preparing yufts are—1. Cleaning of the hides with lime as usual. 2. Swelling or raising in a bath of sour wheat liquor, exhausted tan liquor, or mixture of dog's dung and water. 3. Tanning with various kinds of willows, fir and birch bark being also used. The pelts are first treated for some days in partly exhausted bark, and are next put into tanning tanks, along with bark, or sometimes into a warm infusion of the tanning materials. The tanning occupies from five to six weeks. 4. The tanned hides are placed on the planing block to drain, and are next impregnated with oil of birch. The oil is rubbed into the hides on the flesh side, and when thoroughly impregnated the hides are stretched until

* In some specimens of Russia leather binding in the Patent Office Library, London, not only has the colour faded, but the leather appears to be undergoing a process of decay.—ED. *Fifth Edition.*

they become soft and supple; they are next rubbed on the grain side with a solution of alum, and then grained and dried. The dry hides are dyed in pairs, sewn together in the form of a bag, into which the dye material is poured. When a red colour is desired, the dye is prepared from sandal-wood, with the addition of potash or soda. By more recent methods, the hides are dyed by being brushed over five or six times with the dyeing material. After dyeing, the leather is dressed in the usual way.

Oil of Birch.—The oil of birch employed in the preparation of Russia leather is obtained by *dry distillation.* The whitish membranous epidermis of the birch, stripped of its woody matter, is placed in a copper still, to which is connected a pipe for conducting the volatile products to a receiver containing cold water. About 60 per cent. of the weight of the bark is in this way obtained in the form of a crude oil.

Chevreul investigated the chemical nature of the oil of birch, and found that its odoriferous property is due to a peculiar compound, to which he has given the name of *betuline* from *betula*, the birch-tree.

Morocco Leather.—Not less famous than the leather just noticed is that known as *Morocco leather.* Unlike the former, however, this kind of leather is very extensively manufactured both in this country and on the Continent, and forms an important branch of industry with the manufacturers of light and fancy leathers. *True* Morocco leather is goat skin tanned, and dyed on the grain side. The skins of sheep, however, are extensively employed for conversion into a cheaper variety of this leather, and are, after tanning, dyed in a great number of different colours.

Morocco leather prepared from goat skins is extensively used for carriage-linings, chair-covers, for superior bookbinding, pocketbooks, purses, and many other useful purposes. This leather is remarkable for its glossy, wrinkled, and fibrous appearance. The goat skins from which Morocco leather is manufactured in England are largely imported from Switzerland, the East Indies, Cape

of Good Hope, Memel, Mogadore, Asia Minor, Germany, and other parts of the world. The skins vary considerably in size and thickness, as also in quality, and are imported with the hair on.

An important feature in the preparation of Morocco leather is the tanning process, which is effected with *sumac* in a very peculiar way, as will be explained further on. The goat skins are first soaked, or *drenched*, in water for several days, to soften them, and are next *broken*—that is scraped or rubbed on the beam, on the flesh side, to further soften them and to remove fleshy matters which would interfere with the action of the lime liquor to which they are afterwards subjected. They are then placed in old lime liquor for two or three days, after which they are handled or "drawn," by removing them from the pits by means of small tongs (Fig. 48), and

Fig. 48.

placing them in a heap for a few hours. They are next transferred to a "middling" lime liquor for several days, being frequently drawn as before, and the skins are finally placed in pits containing strong lime liquor, in which they are allowed to remain with frequent handling or "drawing," until the epidermis readily yields to the touch. The liming generally occupies from about ten to fourteen days in summer, but in winter a longer period is required.

Unhairing and Fleshing.—The goat skins, when ready for unhairing and fleshing, are removed to the *fleshing shop*, or beam house, in which a series of *beams*, placed at equal distances from each other, are arranged opposite the windows of the apartment, whereby the workmen are enabled to perform their operations in a good light. Each goat skin is laid smoothly on the beam, with the hair side upward, and the beam man, standing behind the beam, scrapes the hair from the pelt by means of the two-handled unhairing knife. Fig. 49 illustrates the operation. After

being unhaired the goat skins are again steeped in lime liquor for two or three days, after which they are *fleshed* on the beam. The lengthened steepings in the lime-pits naturally cause the lime to enter into the pores of the skin, and therefore its entire removal is the next most important step, so that the tanning principle of the sumac may fully enter into the fibrous structure of the pelt. For this purpose a mixture composed of dogs' dung and water is employed. This mixture, called the *pure*, is of an alkaline nature, and has the effect of convert-

Fig. 49.

ing the lime within the pores of the skins into soluble salts, which eventually become removed by washing and the mechanical processes of scraping or scudding. A great many attempts have been made to provide a less disagreeable substitute for the excrement of dogs, but the fact that this material is still extensively used, especially in England, would indicate that as yet no efficient substitute has been found.

Scudding.—After remaining in the pure for some time, the skins are removed, and after being steeped they are

forcibly scraped, or *scudded*, as it is termed, with a blunt two-handled knife, both on the grain and flesh side, by which the remaining lime and albuminous matters are forced out of the pelt. They are then again steeped for a short time, and the effect of the various operations to which they have been submitted is that the pores of the skins are opened and free from all such matters as would prevent the proper absorption of the tanning principle.

Sumac Tanning.—The peculiar nature of this tanning material, which is of a yellow colour, renders it necessary to apply it in such a way that its action upon the pelts shall be perfectly uniform, a result which would not be attained if the skins were immersed in an infusion of the material in the same way as in ordinary bark tanning. In order, therefore, to insure perfect uniformity in the action of the sumac tannin, the following system is adopted:—The pelts, after passing through the various operations above described, are transferred to an apartment in which they are sewn up into bags by women—each skin forming a bag—with the grain side outward, a small opening at the hinder part only being left for the introduction of a funnel. At Messrs. Bevingtons' Bermondsey works these bags are now made by the sewing-machine. When the bags are made they are thrown into a vessel of water and examined to ascertain if they are properly sewn and free from holes. They are next taken to the sumac tub, which is a large shallow vessel about fifteen feet in diameter, and which is filled with hot water containing a little sumac. Close to this tub is a smaller vessel containing a strong solution of sumac.

The method of filling the bags with the stronger solution is as follows, and is performed by two men and a boy. Taking their places by the side of the smaller tub, the lad takes one of the bags and inserts the neck of a funnel in its opening, when one of the workmen nearly fills the bag through the funnel with the strong sumac solution by means of a ladle (Fig. 50). The second man then takes the bag from the funnel and inflates it with his breath, after which he closes the aperture by tying it

with a piece of string. The bag, in its distended condition, is perfectly free from wrinkles, the presence of which would interfere with the uniform action of the tanning material, and its contained air enables the bag to float in the liquor of the larger vessel. All the bags, as they are filled, are thrown into this larger tub, in which they float like bladders, and they are kept in constant motion for about three hours in this way: two men, one on each

Fig. 50.

side of the tub, take each a wooden paddle, which they work to and fro in the solution, causing the floating bags to roll gently over and over, by which the sumac solution in the bags becomes uniformly diffused over their inner surface, and eventually permeates the entire substance of the skin; the absorption of the tanning principle is greatly aided by the warm temperature of the solution in which the skins are floated. The goat skins being very thin, are effectually tanned by this method in a few hours. In Fig. 50 a workman is also seen in the act of moving the floating bags about in the sumac tub. During the process of sumaching the bags are removed once from the tub, and are piled up in a heap upon a rack near the tub, and by means of their own weight the sumac solution is forced through the pores of the skins. After

this they are subjected to another sumaching operation, and are then once more piled up in a heap to acquire the necessary pressing, by which time the operation is complete.

The bags are now removed to another apartment, where the stitching is undone and the sediment which remains from the sumac is removed from the interior. This refuse generally consists partly of yellowish sandy matter with which the material had been adulterated before importation from Sicily. This waste, being of no farther use in tanning, is sold as manure. The tanned pelts are next thoroughly washed, and are then laid out smoothly upon a sloping board; they are next "struck," as it is termed —that is, scraped and rubbed until they are perfectly smooth. They are then hung up in a loft to dry. When dried they are said to be *in the crust*, and present a somewhat shrivelled and irregular appearance. To render them smooth, preparatory to dyeing them, the skins are first wetted, and then once more *struck*, or smoothed, as before, after which they are ready for the dyeing-house. The process of dyeing Morocco and other leathers is given in another chapter.

Imitation Morocco Leather.—This is chiefly prepared from sheep and calf skins, and is extensively used for bags, bookbinding, chair-covers, and many other useful purposes, and as now manufactured bears a close resemblance to the true Morocco. The sheep skins, before they come into the tanner's possession, are deprived of their wool by a class of manufacturers called *fellmongers*, who receive the skins in the condition in which they leave the slaughter-houses. After the skins are *fellmongered*, the wool is disposed of to the *woolstapler*, and the *fells*, as they are termed, to the tanner and manufacturers of parchment.

The unwoolled sheep skins or fells are treated much in the same way as goat skins; since the skin of the sheep, however, is naturally of a more greasy and oily nature than that of the goat, it requires very careful treatment to remove these greasy matters before being submitted to the operation of *sumac tanning;* the skins are therefore first

submitted to powerful hydraulic pressure, by which the greasy matters are forced out from the pores of the skin. They are then subjected to the same treatment as goat skins, excepting that they are tanned by *immersion* in sumac liquor instead of being sewn up into the form of bags, as in the case of goat skins.

Skiver.—When sheep skins are split by means of the splitting machine, the *grain splits*, as they are called, are converted into a thin variety of leather called *skiver*, which is much used for common bookbinding, pocket-books, hat linings, and other purposes requiring a cheap but strong leather. The *flesh splits*, as we have before said, are employed for making inferior kinds of chamois or oiled leather. The thin skivers, being more readily acted upon by the sumac tan than goat skins, are not sewn up into bags, but are immersed in the sumac tub in an open state, and are tanned in a very short time.

Cordovan Leather.—This leather derives its name from the city of Cordova, in Spain, where it is supposed to have been originally prepared by the Moors. It has a very fine and beautiful grain, and is dyed in every variety of shade and colour. The finest qualities are imported from the Levant, but those of Spain, France, Hungary, and Germany are also highly esteemed. The skins employed in the manufacture of Cordovan leather are those of the goat and dog, and sometimes also hog skins are used, but the leather prepared from goat skins is preferred. The skins after being cleaned and drenched in water, are limed, after which they are again steeped in water for eight to fifteen days, during which period they are repeatedly worked by treading upon them with the feet. At the end of a fortnight they are steeped in a lukewarm mixture of dogs' dung and water, next into a bran bath, and after removal from the latter, the skins are then stretched, pressed between two boards, and rubbed with common salt. They are next immersed in a bath prepared from figs and water. Only skins that are to be coloured black are dyed after being tanned. Black leather is tanned in liquor of extract of oak-bark; that of lighter colour in ooze prepared from

extracts of sumac and nut-galls. When the operation of tanning is complete the leather is withdrawn, taking with it as little liquor as possible, and spread in the shade, when it must be rubbed on the bloom with oil of sesame before the sides have become perfectly dry. After the oil is laid on, drying in the shade is allowed to be completed, when the skins are folded on the flesh side. When it is desired to give the Cordovan a rough appearance, the surface may be rubbed with a blunt knife immediately after spreading. In many parts of Russia wormwood (*Artemisia absinthium*) is employed to fix the colour in the leather. If, for example, it is desired to dye the leather black, a decoction of wormwood is mixed with powdered cochineal, and alum is then added.

In the island of Cyprus, Cordovans are dyed red in the following manner:—The skins, generally about fifty at a time, are placed in a fig bath; they are then passed into a strong solution of alum heated to about the temperature of new milk; they are afterwards hung upon poles to drain, and are next stretched to expel as much moisture as possible; finally, the skins are placed on a table, and after being uniformly stretched, the red colour is applied with a cotton rag. The colouring-matter is prepared by taking ground cochineal and boiling it in soft water in a well-tinned kettle, and during the ebullition 5 ozs. of powdered alum are added for every 5 ozs. of cochineal, and the liquor boils until reduced to one-sixth or one-eighth by evaporation, when it is passed through a filter. The skins are coated four or five times with this preparation, and after being placed in the tanning liquor are submitted to the operations of dressing.

In Hungary and Transylvania, where the manufacturers of Cordovan produce goods which are highly esteemed, the red colour is laid on in a different manner. When the skins have been properly prepared, they are fastened together in pairs, in the form of bags, with the sides to be coloured inside. Into an opening in this bag the warm colouring-matter is poured, and in order to insure uniformity of its action the bag is occasionally agitated by being rolled about.

Roan.—This leather is prepared from sheep skins, much in the same way as Morocco, being tanned with sumac, but in the after processes of currying it is not grained like the latter.

Hungary Leather.—The mode of preparing this leather, which is peculiar, consists in impregnating strong hides with alum, common salt, and tallow, by a quick process, which is generally complete in about two months. The process is thus given by Ure:—"The workshop is divided into two parts. 1. A shed on the side of a stream, furnished with wooden horses, fleshing-knives, and other small tools. In one corner is a furnace with a boiler for dissolving the alum, a vat for immersing the hides in the solution, and several tubs. 2. A chamber 6 feet high by 15 feet square, capable of being made very tight for preserving the heat. In one corner is a copper boiler, of sufficient size to contain 170 lbs. of tallow. In the middle of the stove is a square stone slab, upon which an iron grate is placed about a yard square. This is covered with charcoal. At each side of the stove are large tables, which occupy its whole length, and on which the leather is spread to receive the grease. The upper part below the ceiling is filled with poles for hanging the leather upon to be heated. The door is made to shut perfectly close. The first operations are analogous to those of tanning and tawing, the skins being washed, cut in halves, shaved, and steeped for twenty-four hours in the river. They are cleaned with 5 or 6 lbs. of alum and $3\frac{1}{2}$ lbs. of salt for a piece of hide which weighs 70 to 80 lbs. The common salt softens the effect of the alum, attracts moisture from the air, and preserves the suppleness of the skin. When the alum and salt are dissolved, hot water is poured upon the hides placed in a vat, and they are trampled upon by a workman walking repeatedly from one end of the vat to the other. They are then transferred into a similar vat containing hot water, and similarly trampled upon. They are next steeped for eight days in alum-water. The same round of operations is repeated a second time.

"The skins are now dried either in the air or a stove-room, but before being quite dry they are doubled together, well stretched to take out the wrinkles, and piled up. When dry they are again trampled to open the pores, as well as to render the skins pliant, after which they are whitened by exposure to the sun. Tallow of inferior quality is employed for greasing the leather. With this view the piece is hung upon the poles in the close stove-room, then laid upon the table and besmeared with the tallow melted till it begins to crumble. This piece is laid on another table, is there covered with a second similarly greased, and so forth. Three pounds of fat are commonly employed for one piece of leather. When the thirty strips, or fifteen hides, passed through the grease in one operation are completed, two workmen take the first piece in their hands, and stretch it over the burning charcoal on the grate for a minute, with the flesh side to the fire. The rest are passed over the flame in like manner. After *flaming*, the pieces are successively laid on an inclined table exposed to the fire, where they are covered with a cloth. They are finally slung upon poles in the air to dry; if the weather be warm, they are suspended only during the night, so as to favour the hardening of the grease. Instead of the alum bath, M. Curaudau has employed with advantage a steep of dilute sulphuric acid."

Wallachia Leather.—The following is an abridgment of Morfit's description of the Wallachian method. This leather is prepared by barley dressings in a simple warm vat, and the skins are unhaired by a fermentative process instead of the usual liming. Dry hides, after being softened in water, are first trampled upon and then worked on the flesh side upon the beam, to render them pliant; they are next steeped in water for a short time, and then hung up to drain. They are now examined, to ascertain if the hair comes away easily; for in hot climates during the summer-time this is effected without any other process of depilation. When fresh skins are employed, fermentation is resorted to for loosening the hair. After

removing the tail, horns, and ears, the skins are salted without being soaked. The salting consists in sprinkling each large hide with four to six pounds of salt, alum, and saltpetre; the hides are then folded and stacked in a heap, which is then covered with litter. After a short time the hides become heated, and they are turned over once or twice a day, so as to render the fermentative process uniform throughout. When it is found that the hair yields to the touch, the operation of unhairing is promptly performed, since if the skins were allowed to remain for too long a period under the influence of the fermenting process, the pelt would suffer decomposition and consequent injury. In cases where it is inconvenient to unhair the skins immediately they are in the proper condition, they are steeped in water for one or two days, but not longer; otherwise putrefaction would ensue.

Raising.—When the depilation is effected, the pelts are treated in a bath composed as follows:—For seven skins, each averaging 80 lbs., 20 lbs. of flour are made into leaven, which is worked up into a pasty condition with water; to this a gill and a half of vinegar is added to promote the acetous fermentation. The preparation of the leaven occupies about twenty-four hours, and the vessel in which it is placed must be kept in a warm place, well covered up for three or four days. The tub for seven skins is about five and a quarter feet across, and three and a quarter feet high, and must be perfectly clean and free from any matter which would check the progress of the fermentation. The tub is filled with water, with which the leaven is well incorporated by stirring. Six or seven bucketfuls of the liquor are then put into a kettle and boiled, and a portion of this used to make a uniform paste with ground barley, and this is afterwards thinned with cold water until it has a syrupy consistence. This compound is next boiled until it froths, and is kept constantly stirred with a wooden paddle. When the compound has frothed up three times, it is ladled into the tub to be employed for the dressing, and cooled down by stirring continually in one direction, until the hand can readily bear its tem-

perature. Six pounds of salt are then added and well stirred in, and the tub is then covered up and allowed to repose for a fortnight *to sour*, the mixture being stirred twice a day during this time, and the vessel being immediately covered after each stirring.

The skins being removed from the rinsing water, are strung in threes with a cord and thrown into the tub, where they are allowed to remain for four or five days, being, however, *drawn* twice daily and left to drain for a minute, and then returned to the tub. When the skins are sufficiently soft, they are next fleshed and unhaired, and are then rinsed in clean water, after which they are hung up to drain for twenty-four hours. While the above operations are in progress, a second leaven is prepared from 16 lbs. of meal, and fermented in the same way as the former. The clear sour liquor of the first dressing is now transferred to a second tub, in which the dressing is completed. Six or seven bucketfuls of the clear sour liquor are taken from each tub, and a portion stirred up with 50 lbs. of ground barley—about 8 lbs. for each skin. The remaining hot water is then added gradually, and the whole gently boiled and added to the new dressings and well stirred in. One or two bucketfuls are taken out and heated to near the boiling-point. Another leaven, prepared from 8 lbs. of meal, is then diffused through the tubs, and from 4 to 6 lbs. of salt added to each, with stirring. The process may be simplified by making one steep instead of two, by using at first 30 lbs. of leaven, 120 lbs. of barley, and 10 lbs. of salt for each dressing of six hides.

Relative to barley dressing, Morfit says, "It must be observed that, by the ordinary process, the tanners use at one time, in their first new dressings, just twice the quantity of barley that would be employed here [Wallachia], and, moreover, when their first new dressing is not sufficient, they are obliged to make a second, which renders the process more tedious and expensive than that of Wallachia. It is also necessary to say that, on the addition of salt, the dressing must always be well stirred,

and two or three bucketfuls of the liquor drawn out from each and kept warm, to be poured into the vat in order to maintain the temperature. Several other bucketfuls are also taken out and poured into a reserve tub, so that no more liquor may remain in each dressing than is sufficient to cover the skins subjected to its action. Many tanners believe that it is better to make the whole composition at once, for independently of loss of time and fuel, the *complement* made with the new quantity of barley may retard the progress of fermentation, and the liquor must be heated to a temperature which would be injurious to the skins."

There are several methods of preparing the composition for barley dressing: 1, from barley or rye meal, without leaven, prepared overnight with boiling water; 2, from equal parts of barleymeal and leaven, thinned with water, and heated to boiling just previous to putting in the skins; 3, from wheat bran, in the proportion of half a bushel per hide, weakened with hot water, and after a day's fermentation mixed with 1 lb. of salt for each skin; 4, from leaven of barley or rye, in the proportion of from 6 to 8 lbs. of meal per hide. When the leaven rises, it must be thinned with water at 86° Fahr., and the salt added just before the skins are immersed.

Barley Dressing. — When the fermentation is well established, which is indicated by the liquor becoming sour, the *dressings*, as they are called, are ready for the skins, which are taken from the hangers and passed through the liquor several times, so as to equalise the temperature. They are now left upon the cover of the tub for a few minutes to drain; the liquor is then stirred, and the skins returned to the tubs, which are then covered, and the temperature of the dressings is kept up by additions of the hot reserve liquors. In a quarter of an hour the skins are again drawn out and left to drain as before, after which they are replaced in the tub, and half an hour after are again withdrawn and left to drain for a quarter of an hour. They are then replaced in the tub, again removed, and drained for twenty minutes. In the

fifth dipping the skins are left in the bath for an hour, after which they are drained for half an hour, and then returned to the tub. These operations are repeated in all about eight times. If, on the following day, the hides are not sufficiently raised, they are dipped several times more until the required condition is attained. The heat of the dressings must be kept at from 105° to 120° Fahr. by additions of hot liquor.

Morfit's Remarks on White Dressing.—"Experience has proved that the action of the white dressing is completed in about thirty-six hours; the acetic fermentation which is established so expands the hides that they become as thick as the leather into which they are about to be converted. Care must be taken not to leave them any longer in the liquor after this point has been attained, for it injures the leather, a result which also takes place if the liquor is too strong. After the removal of the skins from the liquor, the latter must be reserved for new dressing, for which purpose it must be heated with a complement somewhat stronger than the first. This acid liquor greatly facilitates the fermentation of the new composition, which sours rapidly. In this manner, when the white dressings are once in train, they may be kept at one-half the expense of flour, time, and money."

When removed from the dressings, the hides are left to drain on the cover, and when cooled are soaked in water for a few moments to remove the viscid coating derived from the barley, and they are then again drained.

Red Dressing.—The skins are now subjected to what is termed the *red dressing*, preparatory to their being placed in the tan-vats. This dressing is made by putting about 40 lbs. of crushed bark, mixed with water, into a tub. Into this the hides are then placed, and allowed to remain for several hours, when they are taken out and drained for a few minutes. A few hours after further immersion this operation is repeated, but previous to returning the skins to the vat the last time an addition of 40 lbs. more crushed bark is made, and this is well stirred in. On the mornings of the second and third

days, 24 lbs. of bark are added, the skins taken out thrice daily, half an hour being allowed for each draining. On the fourth day the skins are drained morning and evening, forty-five minutes being allowed each time. On the morning of the fifth day the hides are taken out, and while draining the liquor is well stirred. The hides are then put back, hair side upward, and a few handfuls of crushed bark thrown in between each skin, and on the top of the last one, which should have its flesh side upward, a layer of bark is spread. The skins are now left for eight to ten days, then removed, rinsed in clean water, and put into the tan-vats.

Bran Dressing.—Some tanners contend that the red dressings may be omitted if the white dressings are made with bran. The unanimous opinion of many tanners whom we have consulted on the subject is in favour of red dressings. The bran dressings are prepared either hot or cold. In the first, the leaven is prepared from yeast, or made with 1 to 1½ lbs. of wheat or rye flour per hide, and kept at a moderate temperature, which quickly sours. After the skins have been soaked and cleansed, they are fleshed and rinsed in water. They are then put into a bath composed of bran liquor as follows: A sufficient quantity of water for all the skins is boiled with bran, in the proportion of 7 or 8 lbs. for each skin; the boiler is then covered, and when the liquor has sufficiently fermented, which is known by the bran rising to the surface, the liquor is transferred to a vat in which the skins were previously deposited. While the skins are getting warmed, another quantity of water is heated until it simmers, when to this is added the fermented liquor first prepared. The skins are then taken out of the vat, and the fresh mixture is poured in, with the addition of salt in the proportion of rather more than 1 lb. per skin, and the whole is well stirred. The skins are now placed in the vat, where they are allowed to remain for about six hours. They are then removed and drained for a short time, and a portion of reheated liquor put into the vat. The same operations are repeated every six hours during two days.

When the hair is loosened it is removed in the usual way, after which the skins are fleshed and soaked in cold water for a quarter of an hour; they are then returned to the vat, and allowed to remain until sufficiently *raised*. By reheating a portion of the liquor from time to time, and keeping the vessel covered, the *raising* will generally be effected by the end of three days. The skins are now rinsed and left in soak for some hours in fresh water, when they are ready for the subsequent tanning operations.—*Morfit.*

Enamelled Leather.—This variety of leather, which for a long period was known under the title of "patent leather," is prepared from calf, seal, and other skins, with a varnish composed of drying oil, vegetable black, and Prussian blue. The skin is first stretched on a flat board, and every trace of grease is then removed from the surface by means of a paste made with fuller's earth and water, which is afterwards thoroughly removed by rubbing. The skin is then ready to receive the first coat of varnish, which is composed of Prussian blue (that which contains some alumina) 5 ounces; drying oil, 1 gallon. These being well mixed or ground together, are boiled to the consistence of "single size;" and when cold, a small quantity of vegetable black is added and ground up with the mixture. The *first coat* is given by pouring some of the varnish over the leather, and then spreading it over thinly with a kind of scraper until the entire surface is evenly coated. The leather is then placed in a drying stove, and when sufficiently set is placed aside to cool; it is afterwards polished with finely-powdered pumice. A *second coating* is then given with the varnish, in which a little *pure* Prussian blue has previously been mixed, and the leather is again stoved and polished with pumice as before. For the *third coat* the varnish consists of a similar mixture, but the oil is boiled until it strings well, and a little more Prussian blue and vegetable black are added, the varnishing, stoving, and polishing being pursued as before. The *last coat*, or finish, is given with a varnish like the third, with the addition of ½ lb. of pure dark-

coloured Prussian blue and $\frac{1}{4}$ lb. of pure vegetable black per gallon, and to this a little oil, copal, or amber varnish are sometimes added. The heat of the stove or oven is usually about 120° Fahr. for enamelled skins, as those of calf and seal intended for uppers, and 175° Fahr. to 180° Fahr. for stout "Japan leather." The exposure in the stove is commonly from six to ten hours.

CHAPTER XXV.

DYEING LEATHER.

Dyeing Morocco Leather.—Dyeing with Aniline Colours.—Dyeing Kid Leather for Boots.—Bath Dyeing.—Dyeing on a Flat Surface.—Aniline Colours in Glove Dyeing.—Dyeing with Pure Aniline Colours.

Dyeing Morocco Leather.—After the goat skins have been sumached, opened, and well washed, they are spread out upon a sloping board and *struck out*, that is scraped and rubbed out as smooth as possible, after which they are hung up in the loft to dry. When thoroughly dried they are in a hard and shrivelled condition, and are said to be "in the crust." To bring the skins to a proper condition to receive the dye, they are first softened or "seasoned" in water, after which they are struck out or smoothed again, when they are ready for dyeing. Since Morocco leather only requires to be coloured or dyed on one side, it is usual to lay two skins of the same size in close contact, flesh to flesh, before dyeing, so that the dye liquor may only penetrate one side of each skin. For *red* Morocco, the skins are first mordanted either with a solution of tin or with alum water, after which they are immersed in a bath prepared from cochineal, boiled in water, with a little alum or tartar added, the liquor being filtered through a linen cloth before use. After about half an hour the skins are withdrawn and then subjected to another immersion in the cochineal bath. They are then rinsed, drained, oiled on the grain side, and hung up to dry, after which they are transferred to the currier.

Black Dye is given by brushing over the grain side a red solution of acetate of iron. For *blue,* the cold indigo vat is used. *Violet* is produced by first dyeing a pale blue, and afterwards dipping in the red cochineal vat. For *green,* Saxon blue, followed by a yellow dye, produced by the chopped roots of barberry. *Puce* colour is produced by logwood, with a little alum added; *olive,* by first passing the skins through a weak solution of copperas, and next through the decoction of barberry root containing a little Saxon blue. After dyeing, the skins are rinsed and drained, after which they are laid flat on a table, and smeared over with linseed oil on the grain side by means of a sponge, to render the surface glossy when curried, and also to prevent them from drying too rapidly and thus becoming hard and flinty.

Dyeing with Aniline Colours.—Since the introduction of the famous aniline or coal-tar dyes, many hues have been given to leathers which could not be produced with equal facility by means of the ordinary dye stuffs. The great brilliancy of the aniline dyes, and the readiness with which they combine with animal substances, render them most potent auxiliaries in the dyeing-room, and with necessary care in their employment they are capable of producing a great variety of tones or shades of exquisite brilliancy.

The *Gerber Zeitung,* to which the leather trades are indebted for much valuable information, has recently contributed a series of memoirs upon dyeing leather with aniline colours, which cannot fail to prove highly serviceable to those who are engaged in this important branch of manufacture. These papers having been reproduced in the *Dyer and Calico Printer,** we are indebted to that useful journal for the following extracts:—

Dyeing Kid Leather for Boots.—The subject is considered in two main divisions, namely, the dyeing of leather for boots and for gloves. The leather used for the first-named purpose is usually that which is too imperfect for the manufacture of gloves. The first process is soften-

* *The Dyer and Calico Printer,* February, March, and June, 1884.

ing the skins in water. The dyeing is effected by two methods—plunging, or dyeing on the flat surface. In the latter case the skin is white on the flesh side. In the old process of dyeing with wood colours, it was considered necessary to adopt the plunging method for all delicate shades, but with aniline colours this is not necessary. With any dilute dye-wood decoctions it is impossible to produce on the skin by means of brushing a full and uniform tone of colour, but with aniline colours it is quite possible to produce on a flat surface the most delicate shades obtainable by plunging. The skins must be stretched out on a flat surface to free them as much as possible from moisture.

As mordants for the so-called kid leather dyeing the following acids are used: sulphuric, phosphoric, tartaric, oxalic, tannic, and acetic acids. Amongst the alkalies used as mordants are soda, potash, and ammonia. Acids must be used with all blue aniline colours, with most greens, as well as with many yellows and browns. Alkalies are used with all red aniline dyes and with kindred shades.

Bath Dyeing.—The modes of dyeing are, as we have said, bath dyeing and dyeing on a flat surface. The first is carried out by filtering a solution of the aniline colour made with hot water. A portion of this solution (of 5 to 10 per cent. strength) is poured into lukewarm water in a vat, and the skins are placed singly in it, a workman treading them down with his feet and keeping them in motion. When the colour has been taken up by the skins, they are removed and subjected to slight pressure, and more colouring matter added to the bath, the process being repeated till the skins have taken the desired shade. To determine what the colour of any particular stage will be when dried, a small piece is cut from a corner and put in a linen cloth which is repeatedly wrung, when the ultimate shade after drying and dressing will be seen with relative accuracy. The skins are now taken out and slightly pressed, the colouring liquor is poured off, except a small residue, to which yolks of eggs and salt are added; the skins are

then replaced and the previous treatment renewed. As this process gives a slightly yellowish tinge, this fact should be kept in view in dyeing the shade in the first instance. The skins are then spread out and allowed to drain, after which they are dried.

To arrive at the desired shades, such as *pink*, eosine is taken for a yellowish tinge. 1. For *pure pink*, eosine two parts, phloxine one part. *Pink with a bluish tinge*, phloxine two parts, eosine one part. Phloxine for a distinctly bluish tinge in a delicate shade. 2. *Straw* is produced by the use of naphtholine yellow, and for specially strong shades some methanil yellow. 3. For *cream*, a very weak solution of naphtholine yellow. 4. *Salmon* is produced by mixing the latter colour and eosine in the following proportions: For the more reddish shades, eosine two parts, naphtholine yellow one part; for more yellowish shades, eosine one part, naphtholine yellow one part. *Buff*, eosine and methanil yellow in equal proportions for the more reddish shades, and equal parts of phloxine and methanil yellow for a bluish tinge. For the above colours it is recommended to add some phosphate of soda to the dyeing-bath, to facilitate the process and impart brilliancy to the colours.

Dyeing on a Flat Surface is effected by first applying to the stretched-out skin a mordant with a medium soft brush. The colouring substance is then applied with a brush. After two applications the skin is drained so as to allow fresh colouring matter to be taken up. When the skin is sufficiently dyed the excess of colour is removed with water. Draining then follows, and the skin is hung up to dry.

The following are some of the shades obtained by this method :—1. *Cream*: Solution of naphtholine yellow in water one-sixteenth per cent. The skin is mordanted with a solution of phosphate of soda in water (proportion 1 : 100). Three brushes of the above weak solution of dye stuff are applied, the skin being drained after the second brushing. As a coating, a solution of dextrine in water mixed with phosphate of soda may be used: phosphate of soda one

part, dextrine two parts, water 100. This coating can be used as a mordant, and produces a silky brilliancy which protects the colour from the influence of the air; otherwise aniline colours fade, even without the action of light. 2. *Straw*: Naphtholine yellow one part, water 400 parts. Treat as before. 3. *Golden yellow*: Methanil yellow one part, water 100 parts. 4. *Pink, with yellowish tinge*: A solution of eosine made with one-sixteenth per cent. of eosine. 5. *Pink, with bluish tinge*: A solution of phloxine (one-sixteenth per cent.). 6. *Pure pink*: A mixture of the above solutions in equal proportions. 7. *Cerise* is obtained with a one per cent. solution of erythrosine, three or four brushes being used in the subsequent process. 8. *Sky blue* is obtained by means of water-blue D.N. in a half per cent. solution. As a mordant, phosphate of soda in one per cent. solution, to which tartaric acid is added in the proportion of $\frac{3}{4}$ oz. to $\frac{1}{3}$ oz. for 22 gallons. The following mordant is recommended for all blue and green aniline colours: water 22 gallons, phosphate of soda $2\frac{1}{5}$th lbs., dextrine $2\frac{1}{5}$th lbs., tartaric acid $\frac{3}{4}$ oz. to 1 oz. 9. *Imperial blue* (cornflower blue) is obtained with water-blue D.N. in a one per cent. solution, the process being as in No. 6. *Grey* in different shades is obtained by mordanting as 1 to 7, and maddering with elderberry juice or dogwood-berry juice (two brushes), then as a coating nigrosine or induline applied in a one per cent. solution. 10. *Green*. A light shade is given with new Victoria green, and a darker shade with extra brilliant green. 11. *Violet*: A one per cent. solution of methyl violet in water. When the skins have been dried they are plunged in water for a few seconds and are then allowed to drain like plates in a rack. A glazing machine may then be used for finish.

Aniline Colours in Glove Dyeing.—While in the so-called kid leather used for boots aniline colours are the principal dye substances used, it is different with glacé leather, in which they are only adjuncts. The use of aniline colours in dyeing glove-leather is divided into the

following:—*a*. Dyeing with pure aniline colours. *b*. Maddering with pure dye-wood or berry-dye solutions, with a coating of aniline, and with the use of various metallic salts for darkening or turning shades. *c*. The mixing of different wood-dyes as maddering substances, with a coating of aniline, without employing any turning substances. *d*. A pure or mixed decoction of dye-wood or berries, shaded with aniline dyes.

Dyeing with Pure Aniline Colours.—The process is almost entirely confined to so-called plunging colours, used to produce the most delicate shades for evening wear, the processes *b*, *c*, and *d* being carried out on a flat surface. Phosphate of soda, with the addition of a very small quantity of tartaric acid, may be advantageously used. The dyeing substance is added to the bath in very small quantities, by which greater purity and regularity of colour are obtained. When the desired tone has been arrived at, a little dextrine is put into the bath and a little borax added. The skins are then well worked for five minutes longer, when they are taken out and allowed to drip, and are afterwards pressed. They are then treated with yolk of egg and salt, which must be greater in quantity than for kid leather. The aniline colours used are naphthol yellow, methanil yellow, eosine, phloxine, methyl violet, nigrosine W., and induline N.N.

The following table shows how the most usual shades required for opera and evening wear are respectively obtained by the old and new methods:—

	Old Method.	New Method.
Cream or Ivory	Decoction of Persian berries, with a trace of Brazil wood	Naphthol yellow in a *very* dilute form.
Straw	Persian berries	Naphthol yellow.
Pink	Brazil wood with a little cochineal	Two parts eosine with one part phloxine.
Violet	Alcoholic extract of logwood	Methyl violet.
Greenish Grey	Elderberry juice, with a little carmine indigo	Nigrosine W., with a trace of lumière green.
Pearl Grey	Elderberry juice and alcoholic extract of logwood	Two parts nigrosine W. and one part induline N.N.

	Old Method.	New Method.
Yellowish Buff	Persian berries and logwood	Four parts naphthol yellow and one part eosine.
Reddish Buff (Flesh colour)	Persian berries, Brazil wood, and cochineal	Two parts of methanil yellow and one part phloxine.

In mixing the above solutions, precision in quantities must be observed, and it is recommended to make solutions of the strength of one-tenth per cent., in which there is one gramme (15·43 grains) of dye-stuff to each litre (·22 gallon) of water. It is best to make the solution in a cold state and in bottles of moderate size, so that they can be shaken to prevent the particles of dye-stuff from caking. After pressing, the skins are placed in a darkened and heated room well ventilated. The salts used for toning down colours are: copperas (sulphate of iron), sulphate of copper, (bluestone), sulphate of zinc, mixtures of copperas and bluestone, and potash alum, used in 1 per cent. solutions. The reader is referred to articles which appear from time to time in *The Leather Trades Review* for more elaborate details of aniline dyeing on leather.

CHAPTER XXVI.

MANUFACTURE OF WHITE LEATHER.

Tawing as distinguished from Tanning.—Tawing Operations.—Kid Leather: Treatment of Kid Skins.—French Kid Leather.—Imitation Kid.—Continental Method of preparing Glove Leather.—Calf Kid for Uppers.—White Sheep Leather.—Splitting Sheep Skins.

Tawing, as distinguished from Tanning.—In the process of *tanning*, as we have seen, the gelatine of the skin undergoes a chemical change when brought into contact with tannin, by which tanno-gelatine is formed—a substance not only insoluble in water, but which cannot be again separated into its two chief constituents, tannic acid and gelatine, by any known means. In the process of *tawing*, however, the skins are subjected to the action of *alum* and *salt*, which, although they convert the skins into a substance resembling leather in some of its attributes, cannot be said to form a true chemical compound with the gelatine, inasmuch as the three substances—gelatine, alum, and salt—can be again separated by treatment with water, as proved by the researches of Davy.

The arts of tanning and tawing are therefore perfectly distinct, and have no relation whatever to each other. Some manufacturers of light leathers, however, carry on the process of tanning calf and seal skins, as well as the tawing of goat, kid, sheep, and other small skins.

Tawing Operations.—The chief operations of tawing are:—1. *Soaking*, or steeping in water. 2. *Breaking*, or scraping on the flesh side. 3. *Liming*. 4. *Unhairing* and *fleshing*. 5. *Steeping in a bran-water drench*. 6. *Working on the beam*. 7. *Treatment with alum and salt*. 8. *Egging*.

The skins which are subjected to the operations of *tawing*, or *alum-dressing*, are those of the kid, the calf, the lamb, and the sheep, the first being employed to produce the well-known *kid leather*, from which the finest sorts of gloves and uppers of ladies' shoes and boots are made. Lamb skins, when prepared by the processes we are about to describe, form an *imitation kid* leather, from which the cheaper kinds of "kid" gloves are made.

Kid Leather: Treatment of Kid Skins.—These skins, which are chiefly imported from Italy, are of very small size, and have the hair on. For leather to be employed for the finest quality of gloves, the skins are obtained from the young goats before they leave the mother to feed on herbage. The imported skins, being in the dry state, are first subjected to the operation of—

Soaking, or steeping in water, in large tubs or vats, wherein they are allowed to remain for about three days; at the end of this time the skins have become considerably softened, when they are next *broken*, as it is termed, on the flesh side.

Breaking.—The skin is laid upon the *beam*, flesh side upward, and is then forcibly scraped with the blunt two-handled tool (Fig. 5), by which it is put into a better condition for liming. The effect of the scraping or rubbing is to break down the fleshy matter attached to the skin, which had become hardened during the process of drying, and thus render the skin more readily acted upon by milk of lime.

Liming.—After the skins have been *broken* they are immersed for two or three days in "old" lime liquor, being "drawn" occasionally, that is, removed from the pits by means of the small tongs (Fig. 48) and placed in a heap, being allowed there to remain for some time, after which they are steeped in "middling" lime liquor for several days, and are finally immersed in strong lime liquor, in which they remain, being frequently drawn as before, until the hair can be readily removed from the pelt by the finger. In from ten to fourteen days, according to the temperature of the atmosphere, the skins are ready

for unhairing. When the liming process is complete, the workman passes his thumb along the upper surface of the skin, when the cuticle, with its hair, peels off with perfect ease, exposing the bare pelt or corium.

Unhairing.—The skins, after being removed from the lime-pits or tanks, are allowed to drain for a short time, when they are removed to the *beam-room*, where they are submitted to the process of unhairing, after which they are again soaked in lime water for several days. They are next *fleshed*, by which the pelt is brought to a tolerably clean condition. The lengthened steeping in the lime liquor, however, has the effect of forcing the lime into the pores of the skin to such an extent that, unless this were removed, the materials subsequently employed would not enter into the interior structure of the skin. To remove this lime and to open the pores, the kid skins are immersed in the *bran drench.*

The Bran Drench is a mixture of bran and water, consisting of about 40 lbs. of bran to 20 gallons of water, which is allowed to undergo what is called *acetous fermentation*, during which *acetic acid* is formed. By the action of the vegetable acid the lime within the pores of the pelt is converted into soluble *acetate of lime*, which is removed by subsequent washings. The skins are steeped in the bran liquor for some days, being frequently turned over, so as to equalise the action of the sour liquor. The *branning* operation is watched with great care, especially when treating such delicate skins as those of the kid. The branning has the effect of opening the pores of the skin besides "killing" the lime, as it is termed.

Striking.—When the skins are sufficiently branned they are next *struck*, or scudded, by being worked on the beam with the blunt knife, by which albuminous matters, and any lime that may still remain within the pores, is effectually worked out. The skins are then again steeped in the bran drench for a day or two, after which they are in a condition to undergo the process of aluming.

Treatment with Alum and Salt.—In this operation the skins are put into a kind of wooden drum or *tumbler*

(Fig. 51). This machine, which is furnished with a door, either in its circumference or at one of its ends, through which the skins and alum mixture are thrown, is constructed so as to rotate upon an iron axle with the usual gearing. In the interior of the tumbler are fixed, at equal distances, a series of perforated *breakers*, upon which the skins, when the machine is in motion, fall, and thus become more intimately brought in contact with the alum mixture. These drums are also used for washing the skins. On each end of the drum are four small holes to admit cold air from without, and to allow the air warmed by the rotary motion of the drum to escape. The materials placed in the drum to act upon the skins for the inferior kinds of leather are alum and salt, in the proportion of about 12 lbs. of alum and $2\frac{1}{2}$ lbs. of salt to about 12 gallons of water for each 200 skins. Sometimes, instead of employing the tumbler, the alum mixture is placed in a tub, and the skins steeped in the solution. Whichever method is adopted, the skins are only subjected to the action of the mixture for about five minutes, by which time the desired effect is produced.

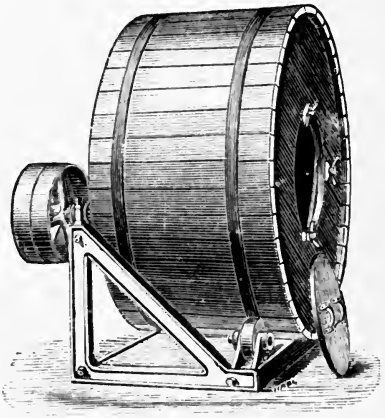

Fig. 51.

Egging—The Emulsion or Paste.—For skins destined to form the finest quality of glove leather, a peculiar kind of emulsion is employed, in which the yolks of eggs form a necessary ingredient. This emulsion is prepared by working up the yolks of eggs, in the proportion of one yolk per skin, with a little flour and water, the whole being vigorously worked up into a thin paste. Into this mixture the skins are put, one by one, and they are trampled upon by the naked feet until the emulsion has become thoroughly

absorbed. The effect of the aluming and steeping in the emulsion is to whiten and soften them, preventing the latter from hardening under the process of drying.

Fig. 52.

Drying.—The tawed skins are next hung upon poles in the drying-room, after which they are stretched out, smoothed, and softened upon the stake.

Staking.—The stake (Fig. 52) is a wooden support, at the upper end of which is a blunt steel, semicircular blade, somewhat like a cheese-knife. The skin, in a nearly dry state, is laid over this, and the workman takes hold of it with both hands and forcibly draws it over the knife in all directions, but more especially from side to side, by which it becomes stretched to its fullest extent, while at the same time all stiffness and rigidity are removed, and it becomes exceedingly soft and pliant.

French Kid Leather.—The following method of preparing this famous leather is thus given by Wagner:* "The so-called Erlanger, or French tawing process, is employed only for the production of the *glacé*, or kid leather, used for making gloves and ball-room shoes. The hair side of the skins intended to be converted into this leather is left unchanged, while as regards wash-leather gloves, which are treated (tanned) with fish oil, the hair side is cut off. The skins intended to be converted into kid leathers are treated with extraordinary care, and thus acquire in a very high degree all the good quality of alum-tanned (or rather tawed) leathers. As these skins are often intended to remain white, or are dyed with delicate colours, the greatest care is taken to prevent any injury—as, for instance, con-

* "A Handbook of Chemical Technology." By Rudolf Wagner, Ph.D. Edited by William Crookes, F.R.S.

tact with oak wood or with iron while wet. Two kinds of skins are employed for conversion into the better varieties of kid leather; one of these, the more expensive, being the skins of young goats fed solely upon milk, the other being lamb skins. Each of these skins yields on an average two pairs of gloves. The leather of which ladies' ball-room shoes are made is obtained from the skins of young calves (so called *calf kid*). The preliminary operations of preparing this leather are exactly similar to those adopted for ordinary white leather, but the tawing operations are quite different, the skins being put into a peculiar mixture by which they are not only tawed, but simultaneously impregnated with a sufficient quantity of oil to render them soft and give suppleness. The mixture consists of a paste composed of wheaten flour, yolks of eggs, alum, common salt, and water. The flour, by the gluten it contains, aids the absorption of the alumina compound, and thus assists the real tawing. The starch does not enter into the composition of the skins, while the yolk of eggs acts by the oil it naturally contains in the state of emulsion, this oil giving the kid leather that suppleness and softness which is so much esteemed in gloves.

"It appears that emulsions made with almond oil (the so-called sweet oil of almonds, a fixed oil), olive oil, fish oil, and even paraffin, may be advantageously substituted for the yolk of eggs. The skins are thoroughly soaked and kneaded in this mixture, to which, in France, there is sometimes added two to three per cent. of carbolic acid, for the purpose of preventing the too strong heating of the skins when impregnated with the mixture and packed in heaps. The skins are next stretched out by hand and dried as rapidly as possible, by exposure to air. Having been damped, a dozen of the skins are placed between linen cloths and trodden upon to render them soft. After this they are, one by one, planed, dried, and again planed. Either by rubbing with a heavy polished glass disc, or by the *apprêteur*, simultaneously with the application of some white of egg, a solution of gum, or of fine soap, a gloss is given to the skins, the hair side of which is the right or

dyed side. The dyes are applied either by immersion or by brushing over the leather, the latter or English method of dyeing skins being more generally practised."

Knapp states that very good white leather may be produced by tawing the epidermis from lamb or goat skins in a saturated solution of stearic acid (stearine) in alcohol, the leather thus produced being very soft, and whiter than ordinary *glacé* leather, besides having a beautiful gloss.

Imitation Kid.—For preparing this kind of leather lamb skins are employed. These skins are imported from the shores of the Mediterranean,* "in the wool," as it is termed, and this, being a valuable commodity, is removed with very great care before the operations on the pelt commence. Since the wool would be impaired if the skins were subjected to the process of liming, the skins are submitted to a process of *sweating,* or putrefactive fermentation, by which the wool becomes loosened from the pelt.

Sweating.—The skins are first steeped, or drenched, in water for several days, after which they are *broken* on the flesh side. They are then again steeped, drained, and while still wet are transferred to a close room, sometimes an underground vault, the temperature of which remains nearly uniform all the year round. In this the skins are suspended from rails or bars. After a certain time fermentation commences, ammonia being given off in considerable quantity, together with a powerful and offensive odour. In about five days the wool becomes loosened from the pelt, but the skins are carefully examined from time to time before the process is complete, as it is of the greatest importance that the sweating process should be arrested and the skins withdrawn at the proper period, otherwise the pelt itself would suffer injury from the decomposition which ensues.

When the sweating is completed, the skins are removed and worked on the beam, or *slimed,* as it is termed, that is scraped on the flesh side with the beam knife, to remove a slimy matter which exudes from the pores. The wool is

* These skins generally measure about 20 inches by 12, and each skin produces leather for two pairs of small gloves.

then removed, and this is afterwards cleaned and prepared for sale. The unwooled pelts are next steeped in the lime-pit for about a week to "kill" the grease, and after this they are fleshed on the beam. This having been done, they are next placed in a *drench* of sour bran liquor for several days to remove the lime and open the pores; they are next treated with the alum mixture, and in all other respects treated in the same way as kid skins.

Continental Method of preparing Glove Leather.—The substances used are alum and common salt as in the ordinary white tanning, but it is especially necessary to obtain *alum free from iron,* on which account this is selected in the most careful manner. Wheat flour and the yolks of eggs are then added in the following proportions. For a thousand skins of young goats or lambs, 25 lbs. of alum free from iron and 11 lbs. of common salt are dissolved in 150 lbs. of water. Next, a firm stiff dough is prepared from the yolks of 500 fresh eggs and 50 lbs. of the very finest wheat flour, to which only enough of the alum solution is added to enable the dough to be mixed. When the egg-yolks and the flour have become very thoroughly and intimately blended, the remainder of the solution is gradually added, forming a thin pap of about the consistence of honey. This pap is called *nahrung* (nourishment, or food). Instead of the egg-yolks it is very common in southern France to employ pure olive oil, but even there, where hens are scarce and eggs dear, the eggs are employed by way of assistance when the finest kind of leather is to be prepared. The *nahrung,* or tawing paste, is placed in a vat, in which the skins are laid, being turned over several times, soaked through, and then a couple of persons with well-cleaned bare feet go into the vat and tramp about for an hour until the liquid part of the paste has been entirely taken up. After this has been effected other workmen relieve the tired trampers, and repeat the operation with the skins which have already absorbed sufficient of the liquor. Next follows the stretching of the leather. Two workmen grasp a skin with both hands and pull it in every direction as powerfully as possible without tearing

it. The skins are then dried quickly and given their lustre by covering the grain side with the *whites of eggs* and rubbing them with a small disc of glass.

The wheat flour used in making the paste has no effect upon the skin, and is only employed as a medium for distributing the egg, oil, and alum evenly and more finely, and to present the alum as well as the oil (which are both necessary for the tawing) in the form of an emulsion, not too thin, otherwise the action upon the skin would be too rapid, and therefore irregular. The claim that the flour serves, by means of its starch constituent, to give the leather a white colour, could only be made by one who was entirely unacquainted with the matter. The starch flour does not dye white; it covers the outer surface with white flakes, which fall off as soon as it dries.

This fine leather has yet to be coloured; for this purpose it is sorted into five or six different grades. Those skins which are entirely free from faults are allowed to remain white, being used for white gloves. Since these are the most delicate, they must also be the most free from faults. The second sort are employed for very clear colours, as yellow, chamois, flesh colour, or rose-red. The third sort is coloured dark yellow, lilac, or sea-green; and the fourth or stronger colours, brown, violet, ash-grey, and green. The fifth grade is employed for all dark shades, and the sixth for black. The colour is applied either by immersing the whole skin, as is done with the lighter colours, or by rubbing the dye upon the grain side, which is the practice with the lighter tints, in order that the colour may not come off upon the hand when it becomes warm. The clear colours do not "crock" so easily, and the little that does come off is hardly noticeable.—*Gerber Courier.*

Calf Kid for Uppers.—The preliminary operations in the preparation of this famous leather are: 1, Soaking and cleansing; 2, Liming; 3, Unhairing and fleshing; 4, Puring; 5, Scudding; 6, Drenching. The skins are next subjected to a series of operations termed *dressing*, the most important being: 1, Alum dressing; 2, Drying;

3, Seasoning; 4, Staking; 5, Shaving; 6, Egging; 7, Dyeing and finishing.

Soaking and Liming.—As the skins are received from the slaughter-house, they are thrown into a large tub of water to cleanse them from filthy matters, after which they are placed in the old lime-pits, in which they are handled as usual, after which they are treated in a stronger or "middle" lime, in which they are again handled; and are afterwards immersed in strong lime, where they are allowed to remain (being drawn each day and returned to the same pit) until the hair is sufficiently loosened, when the skins are drawn and allowed to drain, after which they are removed to the beam-house to be unhaired and fleshed.

**Unhairing and Fleshing by Machinery.*—We had recently the pleasure, through the courtesy of Mr. John S. Carlaw, of Blue Anchor Lane, Bermondsey, of witnessing the unhairing and fleshing of calf skins by a machine of remarkable effectiveness. The blades of this machine, which is called the "Duplex Unhairing and Fleshing Machine" (Janson's patent), are the invention of M. V. Gallien, and so constructed as to act upon the two surfaces of a skin, removing hair and flesh simultaneously, without in the least degree injuring the pelt. The inventor says: "The object of this invention is to give such an edge to the knives or blades of revolving cylinders in machinery, for shaving or otherwise treating hides and skins, that there may be little danger of making too deep a cut into the hide or skin, that the work may be done more efficiently than hitherto, and that the edge may be renewed with great facility. For this purpose an edge is given to these cylinder blades similar to that used on the ordinary currier's or beamsman's shaving knife, that is to say, the edge is slightly bevelled, and in the bevelling a very thin feather or 'burred' cutting edge is formed by the thread or turn-over of the metal. This thread or cutting edge may be constantly renewed by simply reversing the movement of the cylinder, and bringing the blades into contact with an emery plate, file or other sharpener, throwing up the

* See Chap. xxxi. on Machinery Employed in Leather Manufacture for more recent information.—Ed. *Fifth Edition.*

feather or thread, which is then adjusted by the ordinary tool or 'steel.'"

The Duplex Unhairing Machine has been practically adopted by Mr. Carlaw for a considerable time, and has proved to be a most satisfactory piece of mechanism. Mr. Carlaw, who frequently operates the machine himself, informs us that he can readily unhair and flesh in one operation, two and a half dozen calf skins per hour, or one in every two minutes, and the ease with which this is accomplished is really surprising. On examining some pelts after they had passed through the machine we were much pleased with the perfect uniformity and regularity with which the machine had done its work. A very useful feature in this remarkable apparatus is that the pelts are *washed* at the same time they are being unhaired and fleshed, by a series of jets of water issuing from perforated horizontal tubes, which play upon both sides of the skin. After passing through the machine the skins are thrown into a tub of water until required for the next operation.

Puring.—The *pure*—which is a lixivium of pigeons' dung in water—is kept in large tubs, and in this the unhaired skins are placed and allowed to remain, with frequent turning over, until they acquire a certain texture, by which the workman judges the operation to be complete, when they are removed and submitted to the operation of *scudding.*

Scudding.—The object of this operation is to remove a film which remains upon the pelt after the hair has been removed, and also to force out from the skin the salts of lime formed by the action of the pure upon the lime absorbed by the skins in the lime-pits. The "scud" is removed by working the pelt upon the beam with the blunt knife, and after scudding the pelts are thrown into a large tub containing the *bran drench.*

Drenching.—The skins are allowed to remain in the bran drench—which is kept in an active state of acetous fermentation—until the workman judges that the desired effect is produced, which is determined by the appearance

and feel of the pelt under pressure of the fingers. When the skins are first thrown into the drench, they sink to the bottom of the vessel, but as fermentation progresses (which is evidenced by a brisk evolution of carbonic acid gas) the skins rise to the surface, and the liquid becomes covered with a white froth or foam. After drenching the pelts are handed over to the *dresser*, in whose hands they undergo the subsequent operations which convert them into *tawed leather.*

Alum Dressing.—A solution of alum and salt, consisting of three parts of alum to four parts of salt, dissolved in water, is prepared and placed in large tubs, and in these the skins are placed and subjected to its action for about two weeks, or until the skins are properly "leathered," which is ascertained by pressing folds of the skin between the fingers, when, if the *sharp bend* of the skin assumes an opaque white streak, and not transparent, the skin is known to be properly *tawed*—not *tanned*, as some will persistently call it.

Drying.—The alumed skins are next hung up in the drying-room, or *stove*, as it is sometimes termed, until quite dry, when they are called "crust goods," from their exceeding hardness.

Seasoning.—The dried skins are next soaked in water for a short time, to *season* them for the process of staking, which is thus performed:—

Staking.—The skin is laid across the perch, and the workman takes the stake, or "crutch" stake as some call it, in his hand, and placing the cross-handle under his right arm, holds the upright stock firmly in his hand, while with the left hand he seizes a corner of the skin, and forces the blade of the tool (which somewhat resembles the blade of a blunt cheese knife) from above downward, by which means he not only stretches the skin, but also renders it exceedingly soft and pliant.

Shaving.—The skins are next shaved, either by hand or by the shaving machine (Fig. 67), by which the flesh side becomes uniformly levelled by reducing the substance of the stouter parts.

Egging.—The shaved skins are now ready for the egg-paste or emulsion, which, with the skins, is put into a revolving tumbler, and the machine kept in motion until the skins have thoroughly absorbed the composition, when they are withdrawn, stretched out, and conveyed to the dyeing-room.

Dyeing.—The skins are first "mordanted" by being put into a tank containing urine, after which they are drained and folded lengthwise, flesh side inward. They are next placed in a tray containing a hot solution of log-wood. From this they are transferred to a second tray, containing a solution of sulphate of iron (copperas), which, with the former treatment, stains the grain of a deep blue-black. The dyed skins are now laid over a horse or tressel to drain, after which they are hung in the drying-room, where they are allowed to dry gradually. When dry they are again seasoned with water, to prepare them for *grounding*, which operation is performed by scraping the flesh side with the "moon-knife," a tool somewhat resembling the round knife, but, being furnished with a horizontal handle at the lower part of the aperture, this tool is held in one hand, whereas the round knife is held by both hands. The workman holds a corner of the skin depending from the perch with his left hand while scraping the skin with the moon-knife. After grounding the skins are laid flat on a bench or table, grain or coloured side up, and are then ironed with hot irons, much in the same way as linen. The skins are then sorted into sizes for market.

White Sheep Leather.—The unwooled skins, as they are received from the fellmonger, are first steeped in the lime-pits to swell, soften, and cleanse them, being repeatedly drawn and allowed to drain upon inclined tables, which operations are continued for about three weeks. The skins are next rubbed on the grain side with a whetstone fixed into a wooden case with two handles, in order to free them from any adhering filaments of wool. They are then ready for the *bran steep*, which is made by mixing 40 lbs. of wheat bran in 20 gallons of water; in a short time

fermentation supervenes, when acetic and other acids are liberated, which convert the lime within the pores of the skin into soluble salts, which subsequent working on the beam, alternated by washings, removes. It is usual to add some old bran liquor to the bran steep, to promote *acetous fermentation.* During the time that the skins are in the steep they require to be frequently turned over, with careful watching, otherwise the pelts will suffer considerably from the action of the vegetable acids present in the fermenting liquor. In about two days in summer, and eight days in winter, the skins are said to be *raised.* At the end of from two to three weeks they are ready for the next operation, termed *aluming* or *alum dressing.*

Aluming.—The alum bath for a hundred skins is composed of from 14 to 18 lbs. of alum and from 2½ to 3 lbs. of common salt, which are placed in a copper with 12 gallons of water. When the mixture begins to boil, three gallons of it are passed through a colander into a tub, and into this twenty-six skins are introduced and worked one after another. After draining they are put together in the bath, and left therein for about ten minutes to further absorb the liquor. They are now ready for the next operation, which consists in treating them with a *paste* composed of flour and yolk of egg.

The Paste.—This is formed by mixing (for a hundred skins) about 14 lbs. of wheat flour with the yolks of fifty eggs in the following way: the alum bath through which the skins have been passed is first warmed, when the flour is sprinkled into it and well stirred in; the paste is well kneaded by additions of the solution, and it is then passed through a colander, by which it becomes smooth and clear. The yolks of eggs are next added, and the whole thoroughly well mixed by careful and vigorous stirring. The skins are first worked one after another in this paste, and then the whole number are placed together in the mixture, in which they are allowed to remain for a day. They are afterwards removed one by one, stretched upon poles, and left in the drying loft for a week or ten days, according to the season and the thickness of the skins.

The effects of the paste are that the skins become whitened, softened, and protected from the hardening influence of the atmosphere, to which the oily matter of the eggs largely contributes. But for this treatment the skins would be unable to bear the severe processes of stretching or *staking* to which they are afterwards subjected to render them soft and pliant.

Staking.—Before being worked on the *stake* (Fig. 52) the skins are steeped for a short time in clean water; the workman then takes a skin and works it to and fro, flesh side downwards, over the semi-circular knife or blade of the stake with considerable force, by which it becomes stretched in length in the proportion of five to three. By this operation the whiteness of the skin is greatly improved, while it acquires the utmost degree of suppleness which it is susceptible of attaining. The skins are afterwards stretched by hooks and strings and hung up to dry. When dry they are worked on the stretching-iron, or they are polished with pumice-stone. Sometimes a yellowish tint is given to the skins by a mixture of whiting and yellow ochre in a moist state rubbed over the grain. After pumicing, the skins are smoothed with a hot iron, in the same way that linen is ironed, by which the grain assumes a brilliant and glossy surface.

Large sheep skins are also extensively converted into white leather by the process of tawing with alum and salt, for aprons used by workmen employed in iron works, which are found to resist the action of heat better than tanned leather. Sometimes also these skins are partially tanned with bark, and afterwards treated with alum and salt, for making leggings, gaiters, coarse gloves, &c., used by farmers and agricultural labourers. This latter trade is now chiefly carried on in the provinces.

Splitting Sheep Skins.—Amongst the many ingenious contrivances employed in the manufacture of the different kinds of leather, none probably is so remarkable as the machine which is capable of cutting or splitting an unhaired skin into two or even three sections, without forming holes in either section. Although there are

several modifications of the splitting machine—originally adopted, we believe, by the eminent firm of Bevington and Sons—a description of their now famous machine will doubtless suffice to indicate the principle upon which skins are subdivided by machinery. The following details of this important machine are taken from an interesting work entitled *Days at the Factories* :—

"Two rollers (Fig. 53) ranged horizontally in a frame are made to rotate in opposite directions, the vacancy between them being only just sufficient to admit a soft wetted sheep skin or pelt. The rotation of the rollers causes the skin to be drawn slowly between these; but it cannot do so without encountering the blade of a very sharp knife which has a reciprocating horizontal motion, in such a position as to cut the skin into two thicknesses as it passes the knife, one half passing *over* and the other *under* the blade, a most ingenious contrivance for yielding to any inequalities which may occur in the skin. One of the rollers is made in several pieces, so adjusted that in passing over any thickened portions of the skin the common aperture between the rollers is widened at that part. It is one of the peculiarities in the construction of the machine that one of the semi-thicknesses or sections of the skin must be equable and level in every part, while the irregularities which might have existed in the original skin will be thrown into the section. Either section, the 'grain' side or the 'flesh' side, may have this equable thickness given to it according to the mode in which the skin is adjusted on the rollers; and the two portions may have various ratios given to their thickness according to the position of the vibrating knife opposite the opening between the rollers. A sheep skin of the usual size occupies about two minutes in splitting, during which time the knife makes from 2,000 to 3,000 vibratory motions to and fro, cutting a minute portion of the skin at each movement."

A representation of skin-splitting is shown in the sketch (Fig. 53). These machines are now made to split skins into three equal sections or slices, the grain being used

for skiver, the middle portion for parchment, and the flesh

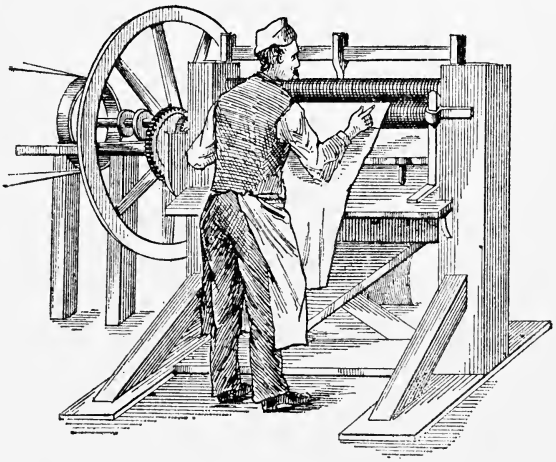

Fig. 53.

side, being of unequal surface, and therefore unsuited for conversion into leather, being used for glue-making. The

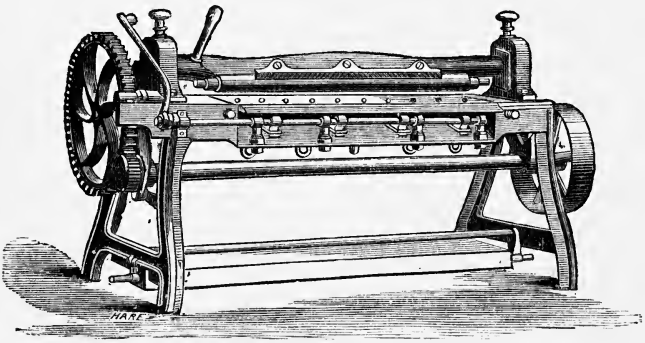

Fig. 54.

American Union Splitting Machine, used to some extent for splitting tanned leather, is shown in Fig. 54.*

* See also Chap. xxxi. p. 412.—Ed. *Fifth Edition.*

CHAPTER XXVII.

CHROME LEATHER MANUFACTURE.

Preliminary Operations.—Liming and Unhairing.—Fleshing.—Puring or De-liming.—Scudding.—Chroming Operations.—Striking-out and Shaving.—Dyeing Chrome Leather.—Fat-Liquoring.—Dyeing Black.—Putting or Striking Out.—Oiling and Drying.—Staking or Softening.—Seasoning.—Glazing.

In the development of what is known as the chrome process, the past few years have witnessed a complete revolution in leather-making, and one which has had far-reaching consequences upon the producing and consuming side of leather manufacture in glacé kid, box and willow calf, sides, belting and harness, &c. We have had an absolute departure from the older forms of tanned leathers, and it is only fair to describe the success of chrome leathers as the outcome of American perseverance and ingenuity in exploiting technical chemistry for the purposes of commercial industry.

Only a few years ago the man who ventured to express his belief that "chemicals" would take the place of oak bark for leather-making was looked upon as a dreamer; now the French tanner of bark upper leather is largely displaced, America has captured the cream of the world's glacé leather trade, and British and Continental manufacturers have taken up chrome leather-making with a fair amount of success.

It may be permissible here to briefly summarise the history and technique of the process, for it is certain much of the business of the leather manufacturer of the

future will depend upon the successful catering for this particular branch of the industry.

As far back as 1858, the late Professor Knapp brought out a chrome process, but it created little notice in the industrial world, and was regarded as of only chemical interest. In 1879, Heinzerling patented a form of chrome leather; this, again, attracted little attention, and it was left to the ingenuity of August Schultz, of New York, to bring out an idea commercially valuable. His patent was dated January 8, 1884; and although it has now expired, it has been the subject of endless litigation in America, which always ended in favour of the patentee.

The Original Schultz Patent.

Briefly put, the principle of the chrome tannage depends upon the formation of chromic oxide in the skin, this being brought about by the reduction of chromic acid with suitable agents. As a good deal of the lighter class of chrome leather is still made in much the same way as by Schultz's method, it will be advantageous to give here his original specification.

"This invention relates to a new process for tawing hides or skins, said process consisting in subjecting said hides or skins to the action of compounds of metallic salts—such as bichromate of potash—and then treating the same with hyposulphite of soda, by which term is understood that salt which is more recently sometimes called 'thiosulphate of soda' ($Na_2S_2O_3$).

"In carrying out my process I unhair the raw hides and prepare them in the same manner in which they are made 'ready' for tanning. If the hides have not been pickled, I subject them to the action of a solution of bichromate of potash in the presence of an acid—such as hydrochloric acid—or, if the hides have been pickled they may be treated in a solution of bichromate of potash in water without the addition of an acid.

"In this solution the hides are left for a shorter or

longer time, according to their thickness and to the strength of the solution employed. A skiver or the face of a sheep skin can be done in a strong solution, as above described, in about fifteen minutes, while a full skin 'roan' would require in the same solution about one hour. I call the solution 'weak' if it contains 5 per cent. or less of the weight of skins of bichromate of potash, and I call the solution 'strong' if it contains more than 5 per cent. of bichromate of potash. It is not material, however, how strong the solution is.

"The skins are completed if small pieces cut from the thickest parts of said skin show that the solution has entirely penetrated. The skins are then ready to be taken out, and after the adhering liquor has run off, the skins are introduced into the second solution, which consists of hyposulphite of soda dissolved in water, and adding an acid, such as hydrochloric acid. The solution may be strong or weak of hyposulphite, and the quantity of acid used at first may be less than requisite to split up the entire quantity of hyposulphite, and more acid may be added if the skins show that more is required, which is indicated by the colour of the skins. When they are done they show a whitish, bluish, or greenish colour, according to the time they are kept in the hyposulphite solution.

"A skiver which first has been exposed to the action of the bichromate for fifteen minutes will be ready by remaining in the hyposulphite solution about twenty minutes. For thicker skins a proportionately longer time is required. For some skins—such as calf or steers' skins—it is desirable that the same, after having been withdrawn from the second or hyposulphite solution, shall be returned to the bichromate solution, which imparts to them a brownish colour, and leaves them in a favourable condition to be coloured black. The colouring can be done after the skins leave the hyposulphite solution, and after they have been exposed for the second time to the bichromate solution. The leather coming from the hyposulphite solution is especially adapted for light or

dark colours, and by proper dyeing methods better and brighter colours can be produced than on leather done by tannin. After the leather is treated in the manner above indicated, it may be coloured, soaped, and greased in the usual way.

"Leather can also be made by reversing the operation and first soaking the hides in a solution of hyposulphite of soda and then exposing them to the action of the bichromate solution. By using the solutions indicated at a heat of about 80° Fahr., the process will be done in a shorter time than if the solutions are used cold.

"By my process the gelatine contained in the hides is rendered insoluble by means not injurious to the leather. If leather made by tannin is put in a strong soda solution, the tannin is extracted, and a dark brown liquor is formed. If leather made by my process is put in a strong soda solution, the liquor obtained shows only a little milky colour.

"Leather made by my process is very strong, soft, elastic, and my process is applicable to hides or skins of every description."

It is obvious that many improvements in the manipulation of the above process have been introduced since it was brought out. As a matter of fact, however, the main principle of the impregnation of the skin with chromic acid remains much the same, and excellence is obtained by a variety of small points in the subsequent mechanical manipulations, mainly by the employment of ingenious machinery and suitable materials. Theoretically, chrome leather is easy to make, but in practice it is very difficult to attain any great amount of commercial success without a large expenditure, enterprise, and technical knowledge.

Chrome leather may be made by two methods, which are technically known as the "one-bath" and the "two-bath" methods. Opinions differ as to the results obtained by each, but, generally speaking, the heavier leathers, such as harness, belting, picker, and calf leathers, are obtained by the use of the one-bath method, which is

very simple in its application, and depends upon the use of a dilute solution of a basic chromic salt, the goods being subjected to its action in gradually increasing strengths until struck through. This method will be dealt with later on.

Light goods, however, such as glazed goat and sheep skins, are generally treated by the two-bath process, and the following summary may be taken as fairly representative of the method now in vogue:—

Chrome or Glacé Goat Skins.

The immense demand for goat skins has led to a regular advance in the price of the raw material, and it has been humorously said that where a goat is wandering, there waits an American for him to die. It will, therefore, be gathered that the demand for skins is very great, so much so that there is now no corner of the world which has not been drawn upon for supplies. The enhanced value of the pelt, too, has led to increased attention being devoted to its primary preparation for storage and transit, and skins are now carefully treated with various compounds for more complete preservation. A large business has sprung up, for instance, with Australia and New Zealand in the export of what are known as pickled skins. These are put through the preparing process of soaking, liming, and unhairing, fleshing, scudding, &c., when they are given a bath of weak sulphuric acid solution. In this they rapidly swell; salt is then added, and the skins become reduced, and are in reality pickled with a sort of glauber salt. The result is fairly good, but the recent Society of Arts committee, appointed to deal with the deterioration of bookbinding leather, has pointed out that the action of the acid often tends to a serious weakening of the animal fibre, and that the resultant leather is sometimes not to be depended upon. The result has been that other preservative agents have been employed, such as formic and acetic acids, and it is claimed their use shows a

distinct improvement upon the ordinary pickling or salting methods.

Various proprietary articles have also been put on the market for the purpose, and one especially has given remarkably good results, viz. Atlas Preservative "S," sold by the Atlas Preservative Company, Windmill Lane Wharf, Deptford, London, S.E. This, it is claimed, perfectly preserves skins and hides in a fresh condition, and no difference can be detected in the finished leather when compared with that made from fresh-slaughtered goods. This preservative may be used with a little salt in such a manner as to keep the skins in a damp and moist condition, or painted in a weak solution on the flesh side, and the skins subsequently dried out and baled for transport. As it is usual to find about ten per cent. of badly damaged skins in certain grades of goat skins, the fact that a method has been evolved to stop this economic waste cannot be too widely known. Experts have reported very favourably on the Atlas Preservative, and good leather has been made from skins treated in all parts of the world.

Preliminary Operations.—A good deal, of course, depends upon the sort and condition of the various goat skins, as regards the first stages of glacé goat manufacture. Skins, as before mentioned, are of world-wide origin, and the pelts from Southern Europe, South America, China, and India all show various characteristics which necessitate differences in treatment. The most esteemed skins perhaps are what are known as Patna skins, coming from India. These, generally speaking, are of good quality and fibre, and produce a fine and close grain, which is a *sine quâ non* in kid manufacture. Taking this class, then, as representative, the procedure is as follows: The skins are first soaked in plenty of clean water; the time varies according to the condition of the skins, but about two or three days should be sufficient to bring them back to a good soft condition. This is greatly facilitated by the addition of a little borax or soda to the soak liquors, about one pound of borax per three hundred gallons being considered

sufficient for the purpose. Sulphide of sodium is also used for the same purpose, and has a decided effect on softening the hard nature of the skins and getting them into condition for liming. Care should, of course, be taken that putrefaction does not set in, and this may be guarded against by changing the first water after about twenty-four hours, and after drawing the skins, to put them into the second soak treated with some disinfectant.

If the skins are very hard and dirty, a "breaking over" between the changes of water is beneficial. This breaking over is done in small tanneries by well stretching and working the wet skin with a blunt tanner's knife over the half-round beam. In the large chrome works, however, this mechanical softening is at times done by the use of the fulling stocks (see Fig. 6). The pounding motion of this machine is very effective where short-haired skins are under manipulation, and from twenty minutes to half an hour is usually ample time to break down the most obstinate pelt. Some classes of skins may be softened effectually in a drum tumbler; but however softened, the general theory should be to bring the pelts back as far as possible to their original soft and pliant condition.

Liming and Unhairing.—In the manufacture of glacé goat, lime and arsenic sulphide are the materials generally favoured for depilation. Experience has shown that the action of lime loosens the hair, distends the fibres of the skin, assists to neutralize the natural fat, and so far acts upon other constituents not necessary to leather-making that they may be mechanically worked out later. In practice it is common to add about 5 lbs. of "red arsenic" to about 100 lbs. of lime slacked in a large tub. The lime should be thoroughly slaked with enough water to moisten it, and the arsenic added and mixed thoroughly with the lime, and the whole mass well stirred. A minor objection is that sulphuretted hydrogen is evolved during the process, so that it should be carried out in the open air, if possible. The arsenic helps to shorten the time of

the depilating process, whilst it also greatly assists in producing leather of a supple texture and a smooth grain.

When the above quantities of lime and arsenic are dissolved the solution is thrown into the pit with sufficient water, care being taken that no undissolved particles or stones find their way in. No definite rule can be laid down, but the quantities stated are sufficient to unhair from five hundred to six hundred skins. After the skins have laid in the solution for a day or so they are hauled up and laid up to drain, the solution being well plunged up before the skins are re-entered. It may be also necessary to strengthen it by the addition of a little more lime and arsenic after a day or two, but a good deal depends upon whether old or new liquors were used at the start; generally speaking, it is inadvisable to use much lime toward the end of the process, as it has a tendency to produce a coarse grain on the finished leather. In some factories it is considered safe to start with a liquor showing about 3° Twaddle, and finishing up with one at about 5° or 6°. The time taken for depilation varies, but may be approximately put at from ten to fourteen days, a good deal depending upon the condition of the skins, the temperature of the solution, and the handling the goods receive. Some manufacturers profess to have had good results in the use of sulphide of sodium for unhairing. This has the disadvantage of practically destroying the hair, and as this in some classes of goat skins is valuable, the sulphide is not much favoured for that reason. Various methods are followed out where sulphide is used; it may be painted on the flesh side of the skins, or the skins may be thrown into a weak solution; or, again, it may be used in conjunction with lime as in the case of arsenic sulphide. However, as practically all the successful chrome goat manufacturers use the arsenic limes, it is not perhaps advisable to take up valuable space by dealing further with the sulphide of sodium methods. If sulphide of sodium is used in conjunction with lime, about a third of the former is sufficient; the goods are

worked much as in the case of lime, and the skins are ready for unhairing in about six to ten days, according to substance, &c. When the skins have had enough lime they are usually washed in water to cleanse them as far as possible, and if the shanks, &c., have not been removed before, they are trimmed away when the skins are ready for unhairing.

The unhairing, being a very simple operation, is often done by hand on the half-round tanner's beam with a blunt knife; of late years, however, this operation has been done by machine. The only drawback to the use of the machine for unhairing is that the holey and defective skins are rather harshly treated, and if great care is not used a skin is often so torn by the action of the spiral knives that it is practically worthless.

Fleshing.—In nearly all large chrome leather works goat skins are fleshed by machine. The operation is, however, comparatively simple, and in countries where there is an abundant supply of cheap labour, it is easy to train men to flesh goat skins in the old-fashioned way with the ordinary tanner's knife. Goat skins, as a rule, are not very fleshy, and most of the loose tissue can be removed by the "brushing" or scraping edge. The machine usually employed for fleshing is illustrated at Fig. 74, the skin being spread flesh outwards on a special rubber roller, and subjected to the action of a cylinder fitted with spiral knives. A modified form of the machine, shown as Fig. 64, is also often used for fleshing. The work done by the machine answers on the whole very well, and is cheaper in Europe and America than the hand process could be. Many small glazed kid manufacturers use the same machines for unhairing, fleshing, and scudding, using different cylinders for the various purposes. As the output of chrome kid, however, has to be very large to ensure a profit, this is not to be recommended, except for exceptional cases, or for the experimental stage of glazed kid manufacture. In machine fleshing great attention should be paid to the cutting cylinder and to the rubber bolster, otherwise the work will be defective, and a good deal of damage ensue

to the skins under operation. In no case should fleshing be entrusted to any but a most intelligent man, who should be encouraged by good wages to become a thorough master of the operation.

Puring or De-liming.—To ensure the production of a good tough and elastic leather with a fine "break" and grain, it is necessary to pay special attention to this process. If lime be present in the skins when they go to the chrome bath, it is turned into sulphate of lime, and the leather is hard and often brittle. After fleshing, the skins are trimmed where necessary, and well washed in plenty of soft water to remove as much lime as possible, and, after draining, are ready for the puring operation. All sorts of de-liming agents have been tried, such as sulphuric and lactic acids, &c., but experience has shown that in the majority of cases the old and disagreeable excrement pure gives the best results. Some manufacturers, however, claim to have used "Erodin," introduced by Mr. J. T. Wood, of Nottingham, and Drs. Popp and Becker, of Germany, with good results. This bate, or pure, depends for its effect upon the bacteriological action, and was invented after much patient experimenting had enabled the inventors to isolate the active organism, and to put a culture and a cheap medium for its propagation before the trade.

Space, however, will not admit of enlarging upon the various de-liming agents which have been tried, and as dog-dung is by many still regarded as the best material for glacé goat, we will devote our limited space to a consideration of its use. In puring it is necessary to remove the dissolved gelatinous substance, the hair sheaths, fat glands, &c., and the lime soap produced by the action of the lime on the natural fat of the skin.

For the heavier kinds of hides and skins, hen and pigeon dung is used for bateing, but in England dog-dung is almost exclusively employed for the process in goat-leather manufacture. It is usually obtained from dog-kennels, and as it varies in strength and characteristics, it is difficult to give any definite directions for

its use. As dog-dung rapidly ferments it should not be exposed much to the air. In many works it is mixed with a little water to a paste, and kept in this way, and in no case should the dung be used until it has been allowed to ferment for six or seven days. In practice a few pails of the semi-liquid dung is added to water at a temperature of about 90° Fahr., the dung being first strained through a coarse bag to remove bits of bone, gravel, and other sediment. The skins soon begin to "fall" in the solution, or lose their plumpness, and are considered to be sufficiently pured when the grain retains the impression of the thumb or fingers. In large works this puring operation is performed in paddles, the strength of the concoction and the time the skins are allowed to remain in it varying according to the system followed out or the ideas of the pureman, who, by the way, should be an experienced and skilled workman.

Scudding.—After the skins have been pured, drenched, or both, as the case may be, they are then carefully worked over on the grain side to remove the lime-soap, pigment, fat, short hairs, and other matter. This is also a very necessary operation, as if much "scud" is left in the skins, the leather on finishing refuses to glaze properly, whilst any hairs remaining would quite spoil the look of the finished article.

In some places the scudding is still done on the tanner's beam with the half-round slate "knife," the workman thoroughly extending and working out the soft and flaccid skin in every direction. It is usual now, however, to do this operation by a machine similar to that described in fleshing, the skin being subjected to the action of a cylinder into which slate tools are let in, the bolster being of stout rubber. The work is done fairly well and very cheaply; but it is a good rule to have the skins examined and to rectify any faults by hand on the beam. Some of the short-haired goat skins, such as Patnas, often scud very badly, and want a good deal of attention to get a clean and fine grain. Others, again,

such as Chinese skins, scud well and make good clean leather with comparatively little trouble.

Too much attention can hardly be paid to this branch of glacé leather manufacture, and attempts at economy here may turn out disastrously later on if the pelts are not freed from impurities and short hair. It is even necessary, in extreme cases, to lightly shave the grain where the liming or puring operations have not been carried out thoroughly. After scudding, the skins are either left for a few hours to drain, or, if necessary, are washed in plenty of clean water. Some manufacturers wash in the paddle in a dilute lactic acid solution, and then in a weak borax solution, 1 lb. of the latter to about 150 to 200 gallons of water being sufficient.

Chroming Operations.—No two glacé goat makers follow quite the same procedure, and whilst some see an advantage in giving the skins a pickle of acid and salt before proceeding to the actual chrome tanning, others dispense with this process as unnecessary. If the former process is done, however, one American authority says that 10 lbs. of salt for each 100 lbs. of drained pelt, dissolved in 15 gallons of water, is sufficient. The skins are run in a drum with this solution for about fifteen minutes, and the acid given. This is prepared by mixing 2 lbs. of muriatic acid (hydrochloric) in a pail of boiling water and cooled with two pails of cold water. This is added to the skins in the drum, which are run for another fifteen minutes, when the skins are ready for the chrome bath.

The saturation of the lighter pelts, such as calf and goat, with the chromic acid is invariably carried out in the paddle or drum, and in all large works separate ones are used for tanning, reducing, washing, &c. Care should be taken to see that the driving arrangements are always in good order, as a breakdown often involves serious trouble and loss.

The chrome bath is prepared by dissolving bichromate of potash in boiling water which is acidified with hydrochloric acid, and this is added to the goods

whilst they are running in a suitable quantity of water. The quantity of bichromate of potash is calculated on the weight of the wet drained skins, and varies from 4 to 6 lbs. per cent. In practice, about 15 gallons of water to 100 lbs. of skins is recommended. The amount of bichromate of potash is not very material, but from 5 to 6 lbs. per cent. of wet pelt is a safe margin. One method is to dissolve 6 lbs. of bichromate of potash in 20 gallons of water, to which is carefully added 3 lbs. of acid. Some authorities also advise the addition of a few pounds of salt to the solution, but of this the writer has had no experience. In practice it is advisable to dissolve the bichromate of potash in a suitable quantity of hot water, and add the solution to the goods whilst in motion in the drum or paddle, the requisite amount of acid being added in successive stages.

The skins are padded in the acidified liquor until they assume a yellow colour throughout, the process being finished when a cut in the thickest part of the skin shows complete penetration. When completely struck through, the skins are taken out of the acid solution, horsed up carefully, care being taken to avoid light and wrinkles, and the excess of liquor struck out by machine. The next process, technically called "reducing," is the reduction of the chromic acid. In many works the skins are first dipped one by one into a weak solution composed of about 4 or 5 lbs. of hyposulphite of soda dissolved in 15 gallons of water; this is sufficient for 100 lbs. of wet pelt. This dipping process is assumed to somewhat "set" the grain side of the leather, and so prevent the tendency of wrinkling or coarseness caused by the sharp action of the reducing bath. This latter is usually done in paddles, 10 lbs. of hyposulphite of soda being dissolved in 20 gallons of water and added to the proper amount of water in the paddle. Five per cent. of muriatic acid, calculated on the wet weight of the skins, is then added, and the skins paddled in this until they lose their original yellow colour and assume a bluish-green tint throughout. It is a good plan in practice to so arrange the

work that the chroming begins in the morning and is completed in the evening. It is of the greatest importance that the reduction should be complete, as no amount of work in the subsequent stages will ever make a first-rate article. It is also an advantage if the skins are sorted into various substances before chroming, otherwise the penetration is uneven throughout the pack, and the heavy skins may be under-tanned. It might also be mentioned that the reduction should be done in a well-ventilated room, as the fumes given off during the process are both disagreeable and detrimental to the health of the workman. When the skins are perfectly chromed throughout they are taken out of the paddle, and are then given a prolonged washing in a weak borax solution, followed by plenty of water. This will neutralise any free acid remaining, and should be continued until no reaction is shown by the leather when tested with litmus paper.

Striking-out and Shaving.—The skins are next well struck out by machine, and passed on to the shaving machine. In the case of goat skins it is often only necessary to level the necks and backs of the skins, although if of stout substance they will require reducing all over. This process must be done with judgment and by careful operators, if damage to the leather is to be avoided. The fact, too, that there is a certain element of danger in working the shaving machine should make the selection of operators worthy of more than ordinary consideration. The cost of machine shaving is not great, and varies from about a penny to threepence per dozen.

Dyeing Chrome Leather.—If the skins are to be divided into black and coloured work, the sorting must be done at this stage; only the finest and most perfect grain skins are suitable for colouring fancy shades, so that those which are marked, imperfect on the grain, or greasy, should be put for black work. At the same time it must be remembered that the quality of the black skins is obviously deteriorated by sorting the

best skins out, so that a good deal of judgment is required.

Dealing with the black skins, the first operation is to mordant them for dyeing. This is technically termed "blue-backing," as it has the effect of colouring the flesh side of the skins a sort of bluish purple. The usual method is to immerse the skin in a solution of warm logwood for about half an hour, using the paddle or tumbler for the purpose. Hemolin is also used for the same purpose, but it is said the skins lose a slight fullness imparted to them by the more astringent logwood. An American authority says the following method of dyeing black produces a very satisfactory result. The skins are drummed in a liquor made up of about 4 ozs. of liquid sumac extract in 5 gallons of warm water, this being the quantity required for about a dozen skins. The skins are then dyed with a purple aniline, about 3 ozs. being sufficient for a dozen skins. The skins are then passed through logwood or hemolin liquor, and then through the iron striker, and finished off with a bath of aniline black at a temperature of about 130° Fahr. Nigrosine, methyl violet, and other anilines are also used for blue-backing, but in many cases glacé leather manufacturers prefer to depend mainly upon the use of the logwood solution, assisted by hemolin, &c., which they consider give the best results generally.

Fat-Liquoring.—When the skins are blue-backed they are then ready for the next operation, termed "fat-liquoring." This is necessary for the thorough lubrication of the fibres, and to produce a supple and tough leather.

Experience has shown that the most convenient time for the process is after the logwood mordanting bath, although the process is sometimes done after the final dyeing. Broadly speaking, the fat-liquor is simply an emulsion in water of some oily or fatty material, or materials. Most leather manufacturers have their own special mixture. Neatsfoot oil, egg yolk, olive and castor oils, special soaps, also sod oil and degras, are all

used, but the first two named materials are perhaps the best for kid leather, which has to bear a high polish and a perfectly clear surface. Turkey red oil has also been recommended for the purpose. Professor H. R. Procter states that Turkey red oil (which is sulphated castor oil) makes a convenient fat-liquor mixed with warm water without soap, and has been advocated where delicate colours are to be dyed after fat-liquoring, although it is said to tend toward making the leather tender and hard.

Fat-liquors should be as nearly neutral as possible, although if any acid has been left in the skins a neutral fat-liquor will cause a deposit of gummy matter on the grain almost impossible to get rid of. Procter gives $1\frac{1}{2}$ per cent. of castor oil soap and $\frac{3}{4}$ per cent. of castor or olive oil on the wet weight of the pelt as being serviceable. Another fat-liquor which is claimed by an American writer to give great softness to the skins is made as follows: 20 lbs. of soft soap and 40 lbs. of sod oil is thoroughly emulsified in 50 gallons of water. The soap should first be boiled in a few gallons of water, and the oil added, and enough water then added to make up the 50 gallons. About 2 gallons of this fat-liquor per dozen is sufficient, and the liquor should be used in the drum at a temperature of 130° to 160° Fahr.

For fine glazed kid the writer has always obtained good results with suitable soap, neatsfoot oil, and egg yolk for the fat-liquor, which is safe and easy to prepare. Fifty gallons of this may be prepared by cutting up 10 lbs. of good soap and boiling in 50 gallons of water, adding 3 or 4 gallons of best neatsfoot oil by instalments until thorough emulsification takes place. It is convenient in practice to use only a part of the 50 gallons for emulsifying, and to add the remainder cold, or nearly so, to bring down the temperature to about 90° Fahr. before adding the egg yolk; otherwise the latter will become more or less insoluble. Two or three gallons of this fat-liquor per dozen is sufficient, although it is obvious a good deal will depend upon the condition and size of the

skins. If any trouble is found in emulsifying, a little borax added to the boiling liquor is usually beneficial.

Skins should be allowed to drain before fat-liquoring, and the fat-liquor added to the goods quickly whilst the drum is in motion. About half an hour is sufficient for the leather to absorb the fatty matters, and a little experience in handling the skins will soon indicate the proper time and quantities required.

At the completion of this process the skins are carefully folded grain out straight down the back, and allowed to lay on a suitable horse for a day, or more, to enable the fibres of the leather to have the full benefit of impregnation with the greasy matters.

Dyeing Black.—After the fat-liquoring operation the skins are then ready for dyeing black. This may be done either by brushing them with the "striker" on the table, or by passing the skins through the logwood and iron solution in suitable vats or trays. Some manufacturers have also tried dyeing chrome goat in the drum, but the writer prefers the tray method for several reasons, which would take up too much space here for discussion. The dyeing liquor varies somewhat in composition, but the following is a safe formula for a black striker: Dissolve, by boiling in 40 gallons of water, 5 lbs. of copperas and about 24 ozs. of blue vitriol, adding 1 lb. of ground nut-galls. The skins are first folded down the centre grain out, and perhaps slicked down with a smooth glass to protect the flesh side as much as possible, and are then passed in small packs through a strong logwood liquor, which is all the better if boiled with a little fustic wood. After this they are worked through the striker in a dilute form until a deep black is obtained. As the iron striker is rather inclined to roughen the grain if used too strong, care must be taken to guard against this. It is more difficult to obtain a good chrome black than would be supposed, and the dyeing should be executed in a light part of the works, and entrusted to the care of one who has had some experience in the matter, otherwise "bronzing" or an ugly-looking grey will be the result.

After the skins are dyed a fine deep black they are well rinsed through a tub of cold water, horsed up, and allowed to drain.

An American authority gives the following method of combining fat-liquoring and black dyeing in the drum. The black is composed of warm logwood liquor, in which 5 lbs. of gum arabic are dissolved, whilst 8 lbs. of copperas are dissolved in another vessel. The gum and copperas solution are then mixed with 25 gallons of strong logwood liquor. When the skins have received the fat-liquor the black liquor is added to the skins whilst the drum is in motion, which is then run for another five minutes; the skins are then washed in cold water and struck out in the ordinary way.

Putting or Striking Out.—At this stage the skins are put out or extended by machine, the machine shown on Fig. 73, with the vertical rising table, being the most suitable. During the last year or two, however, a new machine has been on the market for the purpose, for which a much greater output of work is claimed. This consists of an arrangement by which four tables are kept in motion on the one machine, and under certain conditions it answers well, although some users allege there is hardly time for proper spreading, feeding, and taking off the skins.

The skins should at this stage be struck out moderately tight and laid out flat, grain side up, when they are given a light coat of equal parts of glycerine and water, spread on with a suitable wad of some soft material or a sponge.

In this condition the skins remain for a few hours, and are then reset or again struck out. This time they should be well extended, and all rough and uneven grain removed if the final surface is to be smooth and fine.

Oiling and Drying.—The struck-out skins are then taken to a warm room for preference, and a coat of oil applied to the grain side. This should be of the best quality, and if reliable neatsfoot is to be had it is, perhaps,

the best all-round oil for the purpose. There are, of course, other good oils on the market, but the damage likely to be caused in the leather by unsuitable oil is so great that any new oil should be at first experimented with only on a very small scale.

The oiled skins are next dried out in a heated chamber. Opinions differ as to the efficacy of sharp drying, but the belief is common that the quicker the drying the less likelihood the oil has of either setting on the grain side, or of "spueing" up to the surface on the finishing stages, or even in the finished condition. As a matter of fact, the amount of drying room required is so great in a glazed leather works of any size that it is impossible to find space enough to dry slowly, although it is always a good plan to allow the drying chamber to cool down before the goods are taken out. The method usually followed is to stretch the skins out by the hind shanks on parallel racks studded with sharp tenter-hooks. The work should be so arranged that the skins are left to dry during the night, and taken down in the morning, when they are comparatively cool. In this condition the skins may be stored for some time, and should improve with age, although this ageing process is not as necessary as is the case with alum-tanned leathers, which used often to be kept for six months before finishing.

Glazed Kid Finishing.

Staking or Softening.—The first operation in the finishing of glacé kid is to well soften the leather; the process is known as staking, and is now almost always done by machine (see Fig. 75). The name of the process is derived from the fact that formerly it was done by pulling the skin over an upright wooden stake, into which was fixed a fairly sharp metal plate. In the early days of glacé leather making the workman used his knee as well as his hands for the purpose, the operation being known as knee-staking.

To bring the skins into the right condition for staking, they are covered for a few hours with damp sawdust and

are then taken to the machine The principle of the staking machine is simple, the leather being extended and worked by a blunt knife, the jaws of the machine opening and closing by an ingenious mechanical arrangement. The work is, however, rather tiring, as the pull of the staking knife has to be neutralized by the pressure of the operator's body. Goat skins are usually staked twice, once from neck to tail, and once "to the breath." Care should be taken to see the shanks are opened out and a good pattern given to the skin. Some tanners still have their skins knee-staked after one machining, whilst others have them sorted over, and any which seem at all hard, worked over with a moon-knife or arm-stake. The cost of hand work, however, is so great, that only in few instances is it followed out, and it will probably soon disappear altogether. If the skins are very fleshy after staking they should be lightly fluffed on a wheel covered with fine emery powder, but as a rule a good stiff brushing on the flesh is sufficient before they are passed on for trimming. This consists of removing the edge rags of the skins with a pair of strong shears, and is quickly and cheaply done by girls or women.

Seasoning.—The softened and trimmed skins are then prepared for glazing by being wiped over on the grain side with a mixture known as a "season." This usually consists of blood or albumen solution, to which is added colouring matter in the shape of logwood decoction, ink, or black aniline dye. It is a mistake to give the leather too much seasoning; the idea should be simply to bring the leather into condition for the subsequent glazing process. Many seasons are sold ready prepared; but for the benefit of those who prefer to make their own, the following will be found useful:—

6 qts. logwood liquor;
2 „ ox blood;
½ pt. orchil;
2 pts. water;
¼ „ ammonia;
½ „ milk.

Another—

5 gals. logwood liquor;
5 ozs. copperas;
1½ pts. blood;
5 ozs. glycerine;
8 „ ammonia.

In many factories girls are employed for the seasoning, and their nimbleness and lightness of touch makes them very suitable for the work. In summer time the addition of some cheap antiseptic, such as phenol (carbolic acid), will keep the seasoning from becoming offensive. The season should be spread evenly and lightly with a soft pad and the skins hung up to dry.

Glazing.—This being practically the last operation care must be taken to render it effective. Glacé goat glazing may be called a skilled business: in any event, the proportion of bad work makes it an expensive matter to teach operatives the process, and none but those of a high order of intelligence should be employed.

A good deal depends upon the machine used for the purpose, and the one in general use is known as the "Bower." This is built almost entirely of wood, the pressure of the glazing-glass being regulated by a foot lever and a rocking arrangement fitted with springs at the head of the machine (see Fig. 79).

Iron machines, such as the type shown at Fig. 78, give great satisfaction for the heavier leathers, such as box-calf, &c.; in fact, some tanners use them for the first glazing of kid, but taken all round the wooden "Bower," by reason of its resiliency and cheapness, is the best appliance for the glacé leather maker to put into his factory. The work, however, is rather trying, as the soft leather has to be "humoured" to the work with the hands, whilst in the case of the old-fashioned stiffer leathers, like levant, the leather stood out boldly under the pounding action of the polishing tools. Good supervision pays in glazing, and new beginners should only be entrusted to do common goods for the first glazing.

After the skins have been glazed once they are then again lightly seasoned, hung up to dry, and glazed the second, and, if necessary, the third time. This practically completes the process, although it is an advantage in some cases to wipe over the grain with a clean oily rag. This helps the finish to stand moisture and handling better, and slightly softens the leather, but is optional, and is not followed out in many factories.

This, then, is the end of black glacé or glazed goat manufacture. Enough has been said to give readers a good idea of the process, and given good skins, material, machinery, and skilled supervision, a saleable article may be made by following out the directions set forth. Mention should be made, however, of the fact that even after the leather is made, the chances of commercial success are much improved by careful measuring and grading the skins into the proper classes. Goat skins vary greatly in size, substance, texture, and fineness of grain, and the selection and grading is a work only to be found out by experience in the markets catered for, and should be done by trained sorters, or by the principal himself, who fully realizes the responsibility of this final operation.

Dyeing Fancy Shades on Chrome Goat.

Before passing on to a brief review of the processes in vogue for chroming box-calf, &c., it would be well to give a few hints on the treatment of chrome goat skins which are intended for colouring. As before mentioned, the skins are sorted in the "blue" condition, *i.e.* after they have been struck out from the final washing after chroming. The dyeing is usually carried out in the drum or paddle, solutions of aniline dyes being used for the purpose. Methods differ a good deal, but the writer has found the following to give good results. First, mordant the skins in a weak solution of some tannin. A mixture of cube gambier and fustic extract of about 5

per cent. of the wet weight of the skins, with enough water at about 140° Fahr., will produce a good foundation for most of the ordinary shoe colours. Sumac extract is also useful for the same purpose. These materials should be carefully dissolved and the skins drummed in the solution for about twenty minutes. The skins are then either drained or lightly struck out and fat-liquored. In some cases the fat-liquoring is done after the dyeing, but if the liquor is at all alkaline, the colour is stripped more or less, and often a nondescript sort of shade is the result.

The hot fat-liquor is, as in the case of black skins, added to the drum whilst the goods are in motion, the quantity being less, however, and regulated to suit the requirements of the particular sort of skin under treatment. After the fat-liquor has done its work the surplus water is run off and the dye liquor added. The writer, in actual practice, found it an advantage to take the skins from the drum, and to fold them straight down the ridges with the grain outwards. About one-third of the hot dye liquor is put in the drum, the skins quickly entered and the drum started, and the remainder of the dye added in successive portions. The time occupied by the dyeing is about a half to three quarters of an hour. Although both the basic and acid colours may be used for dyeing chrome leather, the acid range is preferred by many, especially where the water is hard. There is a wide range of these latter, and excellent shades can be obtained by a mixture of acid yellows, brown, &c., shaded with a little blue or green. The amount of dye required of course varies, but from 3 to 6 ozs. per dozen goat skins is usually sufficient. An American authority says that chrome tanned skins may be very satisfactorily coloured with sulfamine dyes, which require no mordant, and produce full, clear, and uniform shades of colour.

In dissolving the aniline dyes care should be taken to see they are well strained through a fine muslin cloth before the solution is added to the skins in the drum, otherwise the undissolved particles are apt to get on the grain of the leather and cause unsightly blotches.

Much space might be taken up with a variety of so-called formulæ for dyeing, but in the writer's opinion this would be of little practical value, owing to the differences in the requirements of the market, the uncertainty in the nomenclature of the dyes, and the various methods of working. Most of the aniline dye manufacturers keep a special range of colours for chrome leather, and are, as a rule, only too glad to furnish what information they can on the subject. Mention, however, might be made of a new dyeing process by what are known as the Corichrome mordants. These have been put on the market by the Chemische Fabrik Guestrow of Mecklenberg, the English agents being Messrs. W. and C. Pantin, 147, Upper Thames Street, London, E.C. These have been used with success on the Continent, and shades produced by the Corichrome mordants are said to be fast to light and almost fast to soap and alkali. No change is said to take place in the shade in the subsequent fat-liquoring in the drum—not even when an alkaline fat liquor is used. The shades themselves are actually determined by the Alizarine or fast mordant dye-stuffs used in the dye-bath (grounding-bath), and are perfectly developed by the subsequent treatment in the Corichrome developing bath (fixing-bath). There seems to be a great future before this method of chrome-leather dyeing, as it promises to do away with many of the difficulties, so far incidental to the process, which are many and formidable.

After dyeing the skins are sometimes fat-liquored—if this has not been done before as just described—and, whether fat-liquored at this stage or no, they are struck out, glycerined, reset, oiled and dried just as described for black glacé.

The finishing is much the same, but it is often necessary to "top-up" the grain with some fairly strong solution of colour, after the first staking, to produce the exact shade required. The "season" used, too, must obviously be different, and the writer has found nothing better for the purpose than a weak albumen solution, tinted with a suitable dye. Dry albumen for the purpose should be left to

dissolve in cold water, and kept sweet with a little dissolved phenol. This should be made in a moderately strong solution, and diluted to the consistency required with cold water, and applied with a soft sponge or rag, carefully and evenly.

The final staking and glazing is followed out in the same manner as described for black work, more care, if anything, being used to keep the skins clean and of even shade. Experiments, of course, should be on a small scale, and frequent tests made before deciding to put a large pack of valuable skins out for any particular shade.

CHAPTER XXVIII.

BOX-CALF MANUFACTURE.

Striking-out and Shaving.—Fat-Liquoring.—Dyeing Black.—Finishing Operations.

THE preparatory stages of chrome calf manufacture are much the same as for wax or kid calf, special care being taken to rid the pelt of lime, &c. For this reason the excrement pure or bate is often supplemented by washing the skins in lactic acid solution, or the bran drench, the final scudding being also very carefully carried out. Some tanners also give the skins a pickle of acid and salt before chroming, claiming for this, that it makes a softer and fuller leather. About 50 lbs. of salt and about 5 pints of sulphuric acid dissolved in sufficient water is enough for one hundred skins, the skins being pickled in about four to six hours, and the surplus liquor drained off before the goods are entered into the chrome bath.

Salt is also often given the skins in the drum before chroming, or in the chrome bath, as it tends to keep the grain from becoming wrinkled and drawn in the process, and produces a softer leather. It also keeps the fibre of the pelt open, and helps the penetration of the chroming liquor.

Calf skins may either be chromed by the two-bath method, as described for goat skins, or by what is known as the one-bath method. This latter greatly simplifies the process as it avoids the uncertainties of the chemical

action incidental to the two-bath method. Various chrome liquors are now on the market, but the first one of any great value was introduced by Martin Dennis, of America, and is still sold under the name of "Tanolin." According to his original patent his liquor is obtained as follows:—First, a solution of neutral chrome chloride is obtained by solving a certain amount of chromic oxide in hydrochloric acid, care being taken that there is always a surplus of chromic oxide, *i.e.* there should always be more chromic oxide present than the added amount of hydrochloric acid is able to solve. To this solution caustic soda, or, better still, bicarbonate of soda, is carefully added until a permanent precipitate of chrome hydroxide is formed.

In this manner chrome-oxychloride or basic hydrochloric chrome oxide is obtained, a compound easily soluble in water, which very easily parts with the superfluous chromic oxide, especially in the presence of bodies possessing great affinity to chromic oxide; for example, gelatinous hide substance. Besides chromic oxide the solution also contains common salt (sodium chloride), which is formed by adding the bicarbonate of soda to the hydrochloric chrome oxide. The presence of salt is of great use in the tanning process, as it prevents the swelling of the hides in the liquor, and helps to promote the tanning process. Very often more salt is added to the bath to ensure a good tannage. By these means a stock of tanning liquor is obtained which is suitably diluted before the skins are placed into same. The process is mostly carried on in paddles, beginning with a fairly diluted solution, and adding more of the stock tanning liquor from time to time, until the skins are struck through a green colour in the thickest part. This process generally lasts from ten to forty-eight hours, according to the substance of the skins. The surplus of acid in the skins is neutralised by giving them a bath containing either calcium carbonate, lead carbonate, barium carbonate, or similar substances.

A good formula published some time ago by Professor

H. R. Procter is as follow:—Take 10 per cent. (of the weight of the skins) of chrome alum, and solve same in a sufficient quantity of water, and solve separately 2½ to 3½ per cent. of soda. Add sufficient of the soda solution to the chrome-alum solution until a permanent precipitate of chrome oxyhydrate begins to form, and then add a small quantity of common salt.

A writer in the *Leather Trades Review* states that he has also obtained excellent results from a chrome liquor prepared in the following manner:—Ten parts of chrome alum are solved in sufficient hot water, and the solution allowed to cool down, then a separate solution of three parts soda is made. Add sufficient soda solution to the chrome-alum solution until a permanent precipitate of chrome hydroxide appears, and then add lactic acid until the precipitate is just solved, and a clear liquor is obtained.

With this solution make a fairly weak bath to start with, and, after allowing the skins to paddle for a couple of hours, add more of the chrome solution, continuing to do so at short intervals until the skins are struck through a greenish colour. The old bath may be used for a new lot of skins, and a new bath made into which the second lot of skins are placed when the first bath is used up, and so on.

Amongst the various ready-made chrome liquors on the market the writer has heard that prepared by Prenzlau's Fabrikwerke, Hamburg, spoken well of. This is sold under the name of "Corin," and the following short description of the method of its application may be taken as being fairly representative. The skins are first placed into a 4 per cent. solution of "Corin," and are allowed to paddle, then more "Corin" is added at short intervals until all in all about a 10 per cent. solution is obtained, in which the skins remain until tanned. The Vacuum Oil Co., Ltd., York House, Norfolk Street, Strand, London, W.C., also sell a one-bath chrome liquor which has given great satisfaction to makers of box and willow calf.

Generally speaking, all one-bath chrome liquors are sold in a highly concentrated form, and the makers give pretty accurate directions as to their employment, and in some cases even send out competent instructors to introduce them.

Both the paddle and drum are used in box-calf tanning, the latter perhaps being, on the whole, the most convenient. After tanning, the skins are well washed in a borax solution of about 2 lbs. per cent. of pelt weight, and finally in clean water until they are free from salt and acid.

Striking-out and Shaving.—The skins are then well struck out, as described in the former chapter on glacé-goat manufacture, and are now shaved. This is now almost always done by machine, and a good operator can do from fifteen to twenty dozen skins per day, if the leather is in good order, and does not require much reducing. Care should be taken to see the cutting cylinder has suitable knives and is in good condition; the grinding of the emery wheel should, as far as possible, be carried out when the skin is not actually under treatment, otherwise the particles of steel may cause trouble at a later stage, especially if fancy colours are to be produced. It is convenient after shaving to weigh the skins, as it furnishes a base for the calculation of the fat-liquor, &c., later on. Care should also be taken that the leather is not allowed to get dry, for it is impossible to damp chrome leather back, as is the case with vegetable tanned leather.

The skins are often at this stage blue-backed in the drum, logwood, methyl violet, nigrosine, &c., being used.

Fat-Liquoring.—This is done in much the same manner as already described for goat leather, the oily emulsion being added in a heated condition to the goods in the drum. Olive, castor, and neatsfoot oils are used in conjunction with various soaps, &c. Turkey red oil is also used, but probably the best all-round results are obtained from neatsfoot oil and egg yolk. The quantity of liquor given the skins varies a good deal, but averages from

about 5 to 10 per cent. of the shaved weight. This, however, is a point best found out by experience.

A good quality fat-liquor soap recommended by Professor Procter is made as follow:—2 lbs. of caustic soda are solved in about 8 pints of water. This solution is poured into 20 pints of castor oil, previously heated to 86° Fahr., continually stirring the whole time until the soap becomes thick; after this, the tub containing the soap is covered and allowed to remain overnight in a warm place. The soap is now ready for use. It is as well, but not essential, to melt the soap again before use in a jacketed pan containing a stirring apparatus. By means of this apparatus a better and more even mixing of the soap is obtained.

The following recipes for fat-liquors have also been collected and published by a writer on the subject:—

1. One pint neatsfoot oil and 1 pint cod oil are stirred together with 1 pint of a 10 per cent. solution of soda, and this mixture is poured into a hot solution of 3 lbs. of soap chips in 6 pints of boiling water, continually stirring the whole time. Five to 10 per cent. of shaver's weight are then added to the necessary amount of water, *i.e.* for 100 lbs. of leather (shaver's weight) about 10 gallons of hot water are taken.

2. 4 lbs. of soft soap are solved in 1 gallon of boiling water, then add 1½ lbs. of degras and ¾ lb. of soda previously solved in water. Five to 10 per cent. of this mixture is thinned with the necessary amount of water as above.

3. 5 lbs. of soap chips are solved in sufficient boiling water, then warm 4 pints of neatsfoot oil, and stir same into the soap solution. Dilute the emulsion as above.

4. Dilute 6 lbs. of soft soap in boiling water, then add 5 pints of linseed oil to same, continually stirring until a good emulsion is obtained. Dilute same as above.

5. 10 lbs. of soap chips are solved in boiling water, then add 4 gallons of neatsfoot oil, and 10 lbs. of egg yolk when it has cooled down sufficiently; stir until thoroughly emulsified, and dilute as above.

6. Fifteen parts of olive-oil soap are emulsified with 4½ parts of olive oil, and diluted as above.

7. For fancy shades of colour the following fat-liquor has been recommended: ½ per cent. castor-oil soap or olive-oil soap and ¾ per cent. castor oil are stirred together until properly emulsified and diluted as above.

8. The following fat-liquor is recommended by Jettmar: 3 lbs. of castor-oil soap, 2½ lbs. of glycerine, 1½ lbs. of castor oil emulsified with 10 pints of boiling water.

Whatever fat-liquor is employed, it should be added warm to the goods in the drum whilst in motion, a fresh liquor being either made by boiling it under a steam-pipe or by mixing in an emulsifier.

The liquor is best added by a suitable arrangement at the side of the drum, which allows it to go through the hollow axle. If the drum is warmed up, so much the better, and it will be found that practically the whole of the fatty matter of the liquor will have been absorbed in about twenty minutes to half an hour.

Dyeing Black.—After fat-liquoring, the skins are dyed black, much the same process being used as that described for glacé goat. The skins are folded grain out from head to tail, passed first through a strong warm logwood decoction, and then quickly through a black or iron striker. A good striker consists of 5 lbs. of copperas and 1½ lbs. of blue vitriol dissolved in 20 gallons of boiling water. This is made up to 40 gallons, and about ½ lb. of ground nut-galls added. The following iron blacks have also been published by an experienced writer on the subject:—

1. Solve 10 lbs. of iron vitriol (copperas) in 8 gallons of water, and then add sufficient ammonia until a greenish precipitate begins to form; add acetic acid in small quantities until the precipitate vanishes, and a clear yellow solution is obtained, which, when applied to the skins with a brush, will give a fine deep black.

2. A cheaper black is obtained by filling a barrel three-parts full of old hoop iron, which should be devoid of rust, adding about 4 gallons of water and about 4 pints of vinegar. Place the barrel in a warm place, and after

about ten days fermentation sets in, which may be noticed by the froth which collects on the surface. The froth should be removed from time to time, and in about three weeks' time the black is ready for use. Before applying it to the skin, about equal parts of stale beer should be added to the black to thin it down.

3. Another good black is obtained by solving 4 parts of iron vitriol and 1 part of copper vitriol (sulphate of copper) in 20 parts of water, and adding 3 parts of stale beer.

The blacking process may also be done by brushing the solution on the skins, which are sleeked out on a table, or the black may be given in a tumbler. A good deal depends on the general arrangement of the work, and no definite rule can be laid down. Some manufacturers claim good results by the use of aniline blacks, and it is certain there is not the tendency to brittle grain, such as occurs at times with the iron striker on black goods. Others state the iron striker gives the best all-round results; but the operation should be conducted by a skilled dyer. If aniline blacks are used for blacking after fat-liquoring, a little acetic acid must be added to the dye solution until it is slightly acid. This will counteract the effect of the alkali given by the fat-liquor soap to the liquor. In dyeing chrome calf in a tumbler a 1 to 1½ per cent. solution of the aniline black is given, and 2 to 3 per cent. of salt added. The temperature should be kept up to about 140° Fahr., the time occupied being about half an hour.

After the skins have been dyed, they are carefully rinsed in water, and set or struck out by hand or machine. They are then given a coat of warm neatsfoot oil on the grain side, and sharply dried in a heated chamber. Many tanners prefer to strain the skins out on wooden frames before drying, and doubtless this gives a better measurement, and preserves the pattern on the skin much better than would otherwise be the case.

Finishing Operations.—When the skins are dry they

are taken to a cool room and allowed to lay for a few days until they are wanted. They are then slightly damped by being covered with moist sawdust, and staked. The method and machine used for the purpose is much the same as that described for glacé goat. The work, however, is harder, and a good deal of judgment has to be used to avoid over-softening the flanks and bellies of the skins. The skins are then hung up and dried slightly, and restaked, after which the edges are trimmed with sharp shears.

Box-calf is then given a seasoning, *i.e.* some suitable solution is rubbed on the grain to prepare it for the subsequent glazing. Nearly every tanner has his own formula for the purpose; but the following will be found reliable: 6 ozs. of nigrosine dissolved in 5 gallons of water; add 2 pints of bullock's blood, 5 ozs. of glycerine, and 8 ozs. of ammonia.

Another recipe: 5 ozs. of copperas are dissolved in 5 gallons of logwood liquor; add to this 2 pints of blood, 5 ozs. of glycerine, and 8 ozs. of ammonia.

A good formula used with success on the Continent is as follows: Beat up the white of three eggs, and then add 2 pints of logwood solution; well strain, and add 1½ pints of ox blood and ½ pint of milk. Weak solutions of albumen and linseed decoction are also sometimes used, these latter, however, being more suited to seasonings for fancy colours, where the above materials are not suitable.

In seasoning, only sufficient of the mixture should be applied to the grain with a suitable pad to enable the glazing to be executed properly, otherwise the latter process will not be a success, whilst the excess of seasoning is likely to peel off in the subsequent boarding. When the season has properly penetrated, the skins are then glazed by machine. There are several types in use, and each make possesses useful features. The pressure used in glazing must not be too great, otherwise the glazing glass is apt to leave marks on the skin which are difficult to remove.

After the first glazing is complete, the skins are grained

by means of the ordinary cork-covered pommel or arm-board. In box-calf it is usual to grain two ways only, once from the head to the tail, and then from belly to belly. It should be noted, too, that it is often advisable in the case of coarse flanky skins to lightly emboss with a suitably engraved roller before graining; this prevents a coarse, unsightly "break," but only sufficient pressure should be used to assist the formation of the natural grain, as an artificial-looking break is strongly objected to.

After graining, the skins are again seasoned lightly; care should be taken the season is not applied too strong, and a shank should be tested once or twice before seasoning the whole lot, and the season modified or weakened to suit requirements. After the second seasoning a second glazing is given, first with a fairly heavy pressure, and finally with just sufficient pressure to remove the tool marks, streaks, &c. A final light boarding or graining completes the process, and after the skins have been sorted into qualities and sizes, the goods are ready for the market.

In conclusion, it may be added that methods in vogue vary a great deal, but if the above directions are followed out, and practical common sense applied where modifications are necessary, there is no reason why a good saleable article should not be turned out. The chrome process, however, requires constant attention to get uniform results, and experiments on a small scale are advisable until success can reasonably be anticipated.

CHAPTER XXIX.

CHAMOIS, OR OIL-LEATHER MANUFACTURE.

Preparation and Frizing.—Drenching.—Stocking or Milling in Oil.—Pressing and Washing.—Finishing.—Chamois Glove Leather.—Bleaching.—Tucking.—Colouring.—Buff Leather.—Liming.—Preparing and Milling.—Scudding and Wash-house.—Buck Skin Dressing.—Milling or Stocking.—Scudding and Wash-house.

The manufacture of "chamois," or oil-leather, is still one of the most important branches of the leather industry, and an enormous home and export trade is done in this material. The preservative or tanning principle is not well understood, but it probably depends upon an oxidation of the fats with which the raw pelt is treated. It should be mentioned that oil tanning is one of the oldest methods known in the preservation of animal skins, and is still practised to this day by savage races.

Chamois leather is now usually manufactured from the flesh splits or "linings" of the sheep skin, whilst white, or "buff" leather, formerly used so extensively for military accoutrements, is made from heavier hides by the same process with slight modifications. The manufacture of chamois is mainly in a few large hands, as the plant is rather expensive, and the amount of capital required considerable. Most tanners utilize the entire sheep skin, the grain side being tanned with sumac and sold under the name of "skiver" for a variety of cheap purposes, whilst the flesh split is either turned into chamois or "pickled" with sulphuric acid and salt for export as the position of the market demands.

Sheep skins are first de-wooled by the fellmonger, and eventually collected by the dresser, who sorts them for the most suitable purposes. Those intended for splitting are given a further liming to plump them, and are then split on a machine with a rapidly vibrating knife. Assuming the flesh splits are to be dressed as wash or chamois leather, the process is as follows :—

Preparation and Frizing.—After splitting, the linings are again put into lime, the lime-pits being so arranged that the solutions are of a gradually progressive strength. The goods are drawn frequently and the lime strengthened as required. This stage of liming usually lasts from ten to fourteen days, according to the class of skins and their condition. The linings are at the end of this time firm and in good condition for frizing, and all rough flesh and roughness can be easily removed with a sharp knife on the beam. Unskilled labour is often utilized for this purpose, and the operation is also done by machinery; but it is doubtful if much real saving is effected. Skins badly frized are said to require more oil and to want extra work in the grounding operation.

Drenching.—This process is usually carried out in tubs or vats, although in some of the larger works the drum or paddle is used. According to a writer in the *Leather Trades Review*, the tubs used are from half to two-thirds filled with water at a temperature of about 70° to 80° Fahr. To this water is added one to one and a half buckets of scalded bran or meal, the bucket reckoned as holding about three gallons. Previous to drenching, the skins are well washed, either in a drum or paddle, through which an abundant supply of clean water is kept running. This will free them from surplus lime and other objectionable matter, and show a saving in the amount of bran required. The skins are then placed in the drench tubs and are continuously stirred, though it is much quicker to use the paddle for the purpose. This will accomplish the deliming or drenching process in about six hours, against twelve to twenty-four required in the tubs. No definite rule can be laid down as to the amount of

drenching required, but an experienced workman will be able to tell when the process has been carried far enough by the feel and general appearance of the skins.

When the skins have been drenched, they are well pressed to remove surplus moisture and grease. This is usually done in an hydraulic press, the skins being arranged between plates, sacking, and wood blocks, the whole process taking about an hour.

Stocking or Milling in Oil.—When the skins are ready for milling or stocking—the process being done in the machine shown at Fig. 6 (page 111)—each skin is well shaken out to get rid of adhering bran or meal, and they are allowed to cool by being thrown on the floor, care being taken to avoid getting them dirty. They are then stocked for about an hour to get them in uniform condition. Then they are taken from the stocks and a three-gallon pail of cod oil is got ready, also a sprinkler made of heather sprigs. With this, one operative sprinkles the skins, whilst another gradually throws the skins into the stocks until sufficient oil has been given. They are then milled for three or four hours, when it will be found the skins are covered with soap, and will also have a soapy, slippery feeling when handled. The skins are now drawn from the stocks and taken to the sheds for air-drying, no artificial heat being applied at this stage.

After about a day's steady drying the skins are again stocked and sprinkled with oil as before, the time being usually three hours. They are now drawn and stoved at a temperature of about 100° Fahr., the operation resulting in making the skins a brownish colour. This process of stocking and drying is repeated several times, until the final heating off, when the skins are hooked by the neck on ranges very closely in the drying stove. In this stove the heat is raised to about 150° to 160° Fahr., when a sharp, astringent odour will be given off.

The skins are then thrown, whilst in the heated condition, in bins or casks, well trodden, and covered with sacking to retain the heat. The temperature will at once

begin to rise, and the skins will require most careful attention. The millman should go frequently from bin to bin and note the temperature. At intervals they are turned by casting them into another bin, the workman using gloves for the purpose, and the goods well trodden down by a lad. This is repeated until the skins are heated off, a point only indicated by experience.

Care should be taken that there is no surplus oil or moisture on the goods, or damage is very likely to result. The workmen should also wear goggles to protect the eyes, as the vapour arising from the skins is irritating. Sufficient goods should be always available to keep up the process of heating, otherwise parts of the leather will remain green, and will become drawn when treated with the alkalies later on. When the goods have assumed a characteristic dark-brown colour they are spread around to cool, and are ready for pressing and washing.

Pressing and Washing.—The skins are then thrown into a vat of water at a temperature of about 110° Fahr., and well pressed in the hydraulic press. Grease will soon begin to exude, and, later on, the substance known as sod oil, all of which being valuable, is carefully collected and treated further if necessary.

When the skins are sufficiently pressed, they are then well washed in an alkaline solution prepared as follows: For ten dozen skins, dissolve 4 lbs. of soda ash and 2 lbs. of soda crystals in sufficient water at a temperature of 120° Fahr. The washing is often done in a paddle, about twenty dozen skins being paddled for about two hours. The goods are now wrung out and the liquor run away. Fresh water is then run in the paddle and the heat raised to 130° or 140° Fahr., and the skins given another hour's washing. In most places some arrangement is made to save the liquor—the first being especially valuable—as this contains emulsified fats which are worth recovering.

Wash-leathers may either be dried after the second washing or given a further liquor to improve their

pliability. A practical writer on the subject gives the following method of preparation: Having run off the second liquor, make a third in paddle as follows: in a small mixer or tub put 10 lbs. of cod oil (about 1 gallon), add 20 lbs. of soft soap; stir the two well together till the mixture becomes stiff, then add one gallon of boiling water until all soap, oil, and water are thoroughly blended. Take of this liquor 3 to 3½ gallons to the paddle of goods, and run for one hour; then draw goods, take to either wringing machine or hydro-extractor.

The skins are now taken to the drying sheds to be dried with air or artificial heat, being hooked by the two hind shanks on tenter-hooks from rail to rail; when dry they are taken to warehouse, and are now called "crust" leather.

For "fleshers," or heavier linings, the process is prolonged, and in washing the amount of materials is increased.

Finishing.—In this condition the goods, as crust chamois, are often sold to dressers and others, who make a speciality of finishing for the market. The skins, after sorting into sizes and qualities, are first staked, either by the arm or upright stake, and are then levelled and worked out by the moon-knife on the perch; this last operation being a skilled operation, and one requiring great care. The skin is extended in every possible way by the workman until it is thoroughly soft, and the fibre can be pulled in any direction.

The goods when finished are then carefully trimmed with shears around the edges, and the holes, where possible, sewn up by hand or machine. They are then carefully sorted into qualities and sizes—the sorter stretching each skin as much as possible—and eventually put up into bundles of thirty, known technically as a "kip." These kips vary in price, some of them coming down as low as five shillings, whilst others may be quoted at fifty shillings.

Chamois leather is almost universal in its application, being used by the tailor, the shoemaker for boot linings,

the fancy leather goods maker, and for an endless variety of domestic purposes. A large export trade is also done in this material, America being one of the best customers of England, whilst Australia, Germany, France, Italy, and South America also take large quantities from our market.

Chamois Glove Leather.—The stoutest and best skins are often sorted out in the crust condition, and finished specially for glove leather. They are first well grounded with a moon-knife on the side which is the most suitable for colouring. After this "paring" operation, they are then carefully run on an emery wheel to produce a fine smooth surface, when they are ready for bleaching.

Bleaching.—In order to produce good clear colours on chamois it is necessary to bleach the leather. This is still done by exposure to light, the process taking two or three days in summer and as many weeks in winter. The skins are first well saturated with a warm solution of soapy water, made by dissolving a sufficient quantity of soft soap in it, and are then taken to a suitable grass plot, the side to be bleached and coloured being exposed to the light. This operation is repeated daily until the desired result is obtained, when the goods proceed to the next operation, known as tucking.

Tucking.—The skins are then thoroughly wetted through in warm water, and are then either wrung or run in a hydro-extractor, shook out, and hung on a suitable wooden horse. Each skin is then separately immersed in a vat of boiling soapy water, and when sufficiently tucked, the skins are at once taken to a drying shed heated up to a temperature of 120° Fahr. When thoroughly dry they are taken to the stakers, who work the skins out either on the upright or by the crutch stake, when they are lightly gone over again on the emery wheel. The best size advised for this purpose is a wheel of about two feet nine inches wide by about nine inches in diameter, which should run at a good speed.

Colouring.—Chamois skins are usually coloured one at a time by spreading them on a convex lead or zinc-covered

table. The colour is usually of a mineral base, ochres and umbers being often used. Of late years more or less successful attempts have been made to use coal-tar colours, and in some hands good results are said to have been obtained. The usual mineral colour is mixed to a thick consistency in a sort of paint, and applied evenly with a suitable brush, care being taken to keep the colour well stirred.

The leather is, after colouring, then dried off in a hot stove, cooled off in the air, and again staked. It is then well dusted or "beaten" over a heavy wooden stool to free it from dust, and again run over an emery wheel, care being taken the emery used is fine, so that the final appearance of the leather may be soft and velvety.

The skins are now recoloured and dusted as before described, and in some cases the three operations involved are again carried out.

Dark shades are often obtained on chamois leather by running the skins in a paddle or drum in a weak bark liquor or aniline dye, being subsequently, when dry, topped up or brushed over with a weak solution of aniline colour.

Deep shades of brown are also at times obtained by hanging the skins in closed chambers, and subjecting the leather to the action of ammonia gas, generated by first running chloride of ammonia solution into a suitable vessel in the chamber, and, later, hot lime liquor to liberate the ammonia.

Buff Leather.—Although buff leather has been to some extent discarded for British army accoutrements, yet a fair trade is still done in this material. Hides of a suitable class are used for its manufacture, the general principle being much the same as in chamois leather. According to a practical writer on the subject in the *Leather Trades Review*, the process is as follows:—

Liming.—The hides are put into old or weak limes at first, handled daily, and the strength of limes increased

for about ten days, when it will be found the hair and cuticle can be removed by pushing over beam with unhairing knife. After unhairing they are put into fresh and stronger limes for a few days, which makes the hides firmer, when they are taken to either splitting or frizing shop.

If split only a thin or light grain is taken off, or if frized the grain is only just taken off, as the flesh part of hide only is used in making buff or oil leather. After frizing, the goods are again returned to the lime-pit for a short time until ready for milling.

Preparing and Milling.—The hides are drawn from the pit, and in place of being drenched are hung out on lines to partially dry out the water in them, by action of sun and air in summer, or in winter dried in a warm atmosphere. The reason they are not drenched is because a firmer leather is required. When sufficiently dry they are taken to the stocking mill. On arrival at the mill they are thrown into stocks and milled for about two hours to distribute the moisture evenly and to soften them, as they have become hard or horny in drying.

They are now drawn from the stocks and laid out to cool. Meantime, to every 3 gallons of cod oil, 1 quart of freshly sifted slack-lime is added, and the mixture well stirred. The hides are now thrown into the stocks, whilst another man sprinkles them with the mixture of oil and lime. After the stocks or fallers are full, run for three to four hours, when it will be found the hides are covered with a kind of lime soap, and have become warm by the constant beating.

The hides are now drawn, and taken and hooked in a warm stove of a normal temperature, fitted with a blast fan, until sufficiently dry. This oiling and milling operation is repeated several days, also the drying, but gradually increasing the warmth of stove each time, until the final milling preparatory to heating off. As the hides cannot be packed into tubs or bins to heat off, they are hooked in a very hot stove with a large coke fire in

the centre, or heated with iron furnace pipes laid on bricks about twelve inches from the ground and all round the stove inside, the furnace door being let into wall at exterior of wall of building. The latter is the better plan with pipes which get red-hot, as with the fire in the centre of the stove it is a very disagreeable operation to make up fires on account of heat and the offensive, irritating smell (acroclin) given off from the hides. After the hides are thoroughly heated off, *i.e.* when they are hard and dry and of a dirty brown colour, they are ready for washing.

Scudding and Wash-house.—The hides on arrival in the wash-house are put into vats containing the following solution: To every hide 3 lbs. of soda ash and 1 lb. of soda crystals, with a sufficiency of water at a temperature of 112° Fahr. The hides are laid out flat in this vat for twelve to fourteen hours; they are then drawn, and the scudder takes them in hand, who places them over a beam and well pushes and presses them to remove as much grease as possible.

They are now returned to the washers, who have heated the liquor they were drawn out of, and also added another lot of soda ash and soda crystals. This is now put into the drum (when the temperature is about 120° to 130° Fahr.). The hides are now thrown in and run for about one and a half to two hours, when they are drawn and the liquor run off. This liquor, also that from the scudding beam, is worth saving.

Another lot of liquor is then made up as follows: ¼ lb. of soda ash and ½ lb. of soda crystals with sufficient water; raise temperature to about 130° Fahr. The hides are now drummed in this liquor for about one and a half hours, and are now drawn and put into a vat containing a fat-liquor in same proportions to number of gallons of water as in treating chamois linings. They are left in this liquor about an hour, and are taken to the drying shed, which is preferably heated with warm air distributed with a blast fan.

When dry they are ready for bleaching and "tucking," which is carried out in the same way as in treating chamois linings. But as hides cannot be handled by grounders over a perch with a moon-knife, they are taken by grounders and put on emery wheels or special hide machines to put the fine smooth face on them.

Buck Skin Dressing.—Buck or deer skins are limed exactly as hides, first for twelve to fourteen days to remove hair and cuticle. After sufficient liming they are ready for drenching, first washing in clear water to rid of surplus lime, then drenched with bran liquor and pressed to get rid of surplus liquor in the same way as in treating chamois. They are now ready for milling.

Milling or Stocking.—The milling is carried out on the same lines as in milling chamois (no lime being added to the oil), but the milling is prolonged as the skins have the grain on, having been neither split nor frized, and it is better, even after buckskins are heated off, to let them lie about for some time to feed on the oil before taking to scudding or wash-house.

Scudding and Wash-house.—The skins on arrival in wash-house are immersed in tubs or bins of hot water placed at side of press, and are now pressed in the usual way (as in pressing chamois). On removal from the press they are immersed in tubs holding about 30 gallons, a hot liquor having been made up with soda ash and lime at a temperature of about 112° Fahr. overnight. They are put in loosely, and are left in this liquor till the grain begins to almost rot, when the skins are drawn and placed one at a time on a narrow beam, the beam not being more than ten to twelve inches in width, when the scudder takes a very keen knife and pushes the grain off, only taking very narrow strips or shavings off straight down the skin from neck to tail or *vice versâ*, and frequently shifting the skin; hence the necessity of a narrow beam. After scudding they are ready for the final washing. The scuddings or shavings are worth saving, being rich in grease.

The skins, having been immersed in strong alkalies in the scudding shop, do not require the second immersion, but are drummed with 30 lbs. of soda ash to each hundred skins in a sufficiency of water at a temperature of about 120° to 128° Fahr. After thoroughly washing they are fat-liquored, as in treating chamois.

When dry they are finished off on emery wheels or buck machines in the same way as in finishing hides.

CHAPTER XXX.

CURRYING.

The Scouring-house.—The Shop.—The Curriers' Knife.—Currying Kip Leathers.—Waxed Kip Butts.—Sorting and Rounding.—Soaking and Softening.—Re-tanning.—Drum-stuffing.—Setting.—Finishing.—Stoning and Starching.—Graining.—Waxing.—Top-sizing.—Currying Satin or Glove Shoe Leather.—Soaking and Splitting.—Buffing.—Blacking and Setting.—Finishing Satin or Glove Leather.—Levant Leather.—Soaking and Splitting.—Setting, Buffing, and Embossing.—Blacking.—Seasoning and Glazing.—Oiling.—Currying Various Leathers. Wax Calf Skins.—Calf Skins for Memel.—High Shoes, Black Grain.—Split Cow-Hides for Brown Bags.—Blocking Boot-fronts.

THE art of currying consists in dressing skins, after they are tanned, for the purposes of the boot and shoe maker, coach and harness maker, saddler, and others, by which they acquire the pliancy, smoothness, *grain*, and colour necessary for the important purposes to which they are to be applied. The operations of the currier are chiefly mechanical, and form a distinct branch of the trade. Many light leather manufacturers, however, combine the art of currying with the other branches of their business. The curriers' shop requires plenty of space, subdivided into many compartments, for carrying on the numerous processes connected with the trade. If possible, the lower part of the building should be devoted to those operations in which large quantities of water are required, as soaking, scouring, and cleansing the leather.

The Scouring-house is supplied with a series of wide tubs, in which the leather undergoes a preliminary soaking; there is also a large, flat, and smooth stone, about 8 feet long by 4½ feet wide, supported by woodwork or masonry, upon which the leather is scoured. This stone has a slight inclination, so that the water used in scouring may freely run off the table on the opposite side to that on

which the workman stands. A block of sandstone, called the *rubstone*, from 2 to 3 feet long and 9 or 10 inches wide, fixed on a trestle, is employed by the workmen for sharpening their various tools. A finer stone, called the *clearing-stone*, is used to remove the marks produced by the coarser stone.

The Shop, as it is called, is a light and generally spacious apartment, in which is the *beam* (Fig. 55) on which the leather is *shaved*. The beam is constructed of a stout block of wood, upon which the workman stands, and into one end of which a strong plank of hard wood is firmly secured, at an angle of 80° to 90°. The working beam is about one foot in width, and its height is regulated according to the height of the workman, each man having his beam adjusted to suit his convenience. On the face of this *upright*, as it is called, a piece of hard and perfectly smooth wood—generally *lignum vitæ*—is attached, and which agrees with the edge of the knife used in the operation of shaving. It is of the utmost importance to the operator that his knife and beam should be in perfect order, otherwise the skins would be liable to injury from the irregular action of the tool.

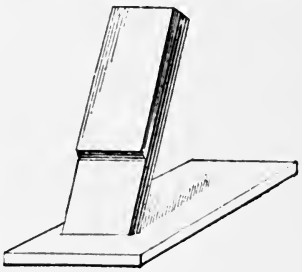

Fig. 55.

A series of tables, the plane surfaces of which are usually made from mahogany or marble, are firmly fixed to the floor of this apartment, near the windows, so that the workmen may have the full benefit of the light. At a short distance from each table, and behind the workman, is a wooden trestle, across which the currier throws each piece of leather after he has worked it on the table in any of the dressing operations. There are many compartments in the currying-shop, each being devoted to some special branch of the business, and furnished with one or more tables and trestles,

and the particular tools required for the operations to be conducted therein.

The Curriers' Knife.—The most important tool is the curriers' knife (Fig. 56), which consists of a blade of fine steel, tempered in a peculiar way, and firmly riveted between two plates of iron. It is furnished with two handles, one of which is horizontal and the other vertical, the latter being held in the left hand. The method of giving an edge to this tool, which is remarkable, is thus described by Ure: "This instrument is taken to the *rubstone* and ground to a perfectly sharp edge by successively rubbing it forward and backward, care being taken to keep the edge *true*, that is *straight*. When this has been satisfactorily accomplished, it is still further rubbed on a Scotch or Welsh stone called the *clearing-stone*, until the scratches of the rubstone disappear. In this operation a fine thread or *wire* forms on the edges, for the knife has two edges, which must be carefully got rid of, after which it is wiped dry and the edges greased with tallow or oil. The workman then takes a strong steel, and placing himself on his knees, he fixes the knife with the straight handle against any firm body and the cross handle between his knees; then holding the steel in both hands, he carefully rubs it forward and backward the whole length of the edge. During this operation the knife is gradually raised by means of the cross handle until it is nearly perpendicular; by this means the edge is turned completely over. If the knife is not well tempered the edge thus obtained will be irregular or broken, in either of which cases it is of no use whatever. To keep the instrument in proper order requires great skill on the part of the currier.

Fig. 56.

The edge is so delicate and liable to injury that it cannot be used more than a minute or two without losing its keenness. To restore this a very carefully prepared small steel is used (Fig. 57); the point of the steel is first run along the groove and then along the outside edge.

Fig. 57.

The knife is used as shown in Fig. 58, the operation here depicted being known as hand-shaving. The process is now often done by machine, which, together with the modern methods of currying, are now dealt with.

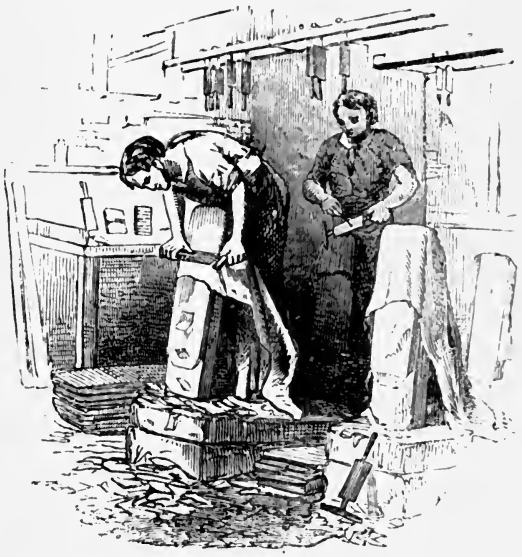

Fig. 58.

Currying Kip Leathers.—Whilst it must be acknowledged the old methods of currying produced a leather which proved serviceable in wear, experience has shown that its manufacture has lately produced little profit to the currier. The principles underlying the treatment of leather by the currier remain, it is true, much the same, but machinery has displaced hand labour to a great extent, whilst some processes have either been dispensed with altogether or very much shortened. It is only fair

to say that the advance in leather manufacture is largely due to American initiative and enterprise, for our markets are flooded with cheap-dressed leather from the United States, whilst American machinery is being sold all the world over, and copied by competitors everywhere.

The extent of the American trade in leather is clearly shown by a reference to official statistics, and it speaks volumes for the cheapness and excellence of the trans-atlantic product, if we remember that 515,686 cwts. of rough and dressed leather were bought in 1905 by Great Britain alone. The business is an enormous one, and it is obvious that, with such competition to face, the British currier has had to get into line with the American, and it is proposed to here briefly describe a few of the methods now in vogue in our more up-to-date leather works. Needless to say, they vary according to the particular market catered for, or the fancy of the foreman or manufacturer, but the principles are much the same, whilst the machinery employed is similar in large and small establishments. As a chapter is devoted elsewhere to the consideration of modern leather manufacturers' machinery it will not be necessary to give needless details here, beyond just the points required to make matters understood. Since this book was first written, the causes alluded to above and the introduction and popularity of the chrome process have lessened the consumption of stout upper leather enormously. In fact, many go so far as to say that the total extinction of wax leathers, *i.e.* leathers finished black on the flesh side, is only a question of time; others, it is true, do not hold this view, for wax leathers possess qualities which make them specially suitable for the heavy hard wear of the mechanic, agriculturalist, and other wearers who require a boot fairly waterproof, with a certain amount of porosity and at a low price. For these reasons, then, waxed leathers are still popular, but have to be produced at a much lower price than was formerly the case; and it is proposed in this chapter to give an outline of the processes involved in the currying of kip butts, a leather which has even now a large sale.

Kips, it should be said, are the hides of the native cattle of India; these are imported in enormous quantities both in the raw and partly tanned condition; and to a large extent the prosperity of Leeds as a leather centre has been built up on the successful exploitation of this special trade.

Waxed Kip Butts.—It will be more convenient for the purposes of discussion if we consider the kips here alluded to are those which are bought in the half-tanned condition by the currier. This leather is imported by merchants into England, and at intervals auction sales are held in London, a sample of the goods being first inspected by the prospective buyer. The buying is mainly done by the buyers' broker, whose small commission is more than saved by his expert knowledge placed at his clients' disposal, whilst it is also an advantage that competitors should not know what other buyers are obtaining. The tanned kips are selected into qualities and weights and carefully catalogued, and the buyer naturally selects the various "marks" and average which suits his particular trade. The larger buyer of Indian kips also purchases what are known as "original bales" direct of the importers, but as these hides run rather irregular in weight and substance, it is more economical for the smaller currier to buy the selected classes at the London sales. The character of the Indian tannage varies greatly with locality; for instance, Bombay kips are clean and well got up, but somewhat spongy, whilst Madras are hard, and often badly plastered on the flesh side.

Sorting and Rounding.—We will assume, then, the currier has obtained his kips, and that they are in his warehouse. The first operation is to sort for the various purposes required, throwing out all the badly-flayed and branded kips for levant or lining leathers, or any purpose where the perfect flesh side is not a *sinê qua non*. After sorting, the kips are "rounded" or cut up into butts,

shoulders, and bellies, the butts, as a rule, being the only part sufficiently compact in the fibre to make waxed leather.

Rounding is a process requiring great care and judgment, and should only be undertaken by a man of experience. No two kips are exactly alike in growth, and it is easy to leave an inch or two on the offal which should have been allowed to remain on the butt, or *vice versâ*. A rough idea will be gathered of the usual method followed out in rounding kips by an examination of the diagram shown in Fig. 14 (page 127).

After rounding the kips the butts are carefully weighed and put up into "packs" or "lots" of about five dozen. It is needless to say that a proper stock or warehouse book should be kept of all lots going out, and that the warehouseman should, on giving out the goods to the currier for dressing, also give him the stock number, so that track may be kept of the leather right through the works to the finishing department.

Soaking and Softening.—On receiving his "lot," the currier proceeds to soak or dampen down the leather; it is important this should be done with care, otherwise the subsequent operation of shaving is rendered very difficult. The leather should be given just sufficient water, so that on doubling back the grain side, the moisture just oozes out. In very cold weather it is an advantage to soak the harder tannages of Indian kips in warm water. The Madras leather especially is usually undertanned, plastered with mud or grease on the flesh side, and so compressed by various methods that it is often difficult to get the leather to take the water at all unless it is warmed. Of course, it goes without saying that excessive heat must not be used, otherwise damage to the leather is the result; but it is a pretty safe rule that if the workman can bear his hands in the soak-tub, the water is not too hot for the leather.

After soaking, the leather is usually allowed to lie in pile for a few hours, so that the moisture permeates evenly through the fibre. After this the kips are

softened in a drum-tumbler, no further water being added. This has the effect of taking the excessive stiffness or "bone" out of the leather, thus rendering the subsequent operation of shaving much easier.

Before shaving, however, the butts are cut down the centre, and the two halves plainly marked on the grain side with the stock number and the "fellow mark." This is done so that the two halves may be matched up later on in the currying process.

We now arrive at the shaving operation, which has been fully explained at the opening of this chapter. This important operation is, in many factories, still done by hand, *i.e.* by the use of the double-edged knife pressed smartly with a downward stroke on the flesh side of the leather over a sloping *lignum vitæ* wood block (Fig. 58). The skilled kip-butt shaver levels to some extent the inequalities of the leather, and at the same time endeavours to pare out the veins, flaws, and other defects of the leather. The shaving must be free from knife-galls and scratches, the latter especially showing up in a very unsightly manner when the leather is finished. Generally speaking, the aim of the beamsman, or shaver, should be to produce a fine and even surface at the least possible loss of weight and appearance.

The introduction of the splitting, and later the shaving machine, has, however, affected the art of the old craftsman, and it seems only a question of time when the whole of waxed leather will be shaved by mechanical methods. Turning first to the splitting machine (see Fig. 54, page 322, and Fig. 68, page 412), wonder may be expressed that this easy and cheap way of levelling leather has not long since superseded shaving for wax leathers. Experience has, however, taught that split leather does not produce so fine and dense a fibre as that obtained by hand shaving. It is true, kip butts are sometimes lightly split, but these are invariably re-shaved, or "flatted," to minimise the effect of splitting as much as possible. Still, where excessive fineness of face is not an absolute necessity, it

is often advantageous and economical to take off a light split from the rump part of the butt, as it obviously saves both labour and material. No amount of work and material will, however, make a badly split kip butt equal in appearance and value to the shaved article, so that the operation, if done at all, must be done with great care and judgment.

As may be gathered from the chapter on leather-dressing machinery, a good deal of shaving is now done by machine. In fact, practically all the lighter upper leathers which are finished on the grain side are now shaved in this manner, but it is still an open question in the minds of experts whether there is any great saving in the use of the machine on waxed goods. As a matter of fact, both hand and machine methods are in use by equally progressive concerns; but it is fair to say that some manufacturers of the very best waxed butts still favour the ancient method of hand-shaving. The objections urged by many against the shaving machine seem to be much the same as those experienced by split leathers. Still, the difficulties incidental to machine kip-butt shaving have certainly been overcome by some curriers who are turning out a good article. These leather manufacturers now sort out the various weights, and use different cutting cylinders to suit the substances required, and apparently the finished wax leather appears equal in every respect to the hand-shaved article. It seems, therefore, extremely likely that it is only a question of time when waxed leather as a whole will be shaved by machine, for continual improvements are being added, whilst the currier has profited by experience, and year by year more fully understands the capabilities of such profitable mechanical aids.

As shaving machinery is more fully dealt with elsewhere, we will proceed to take our shaved butts to the next operation.

Re-tanning.—As the butts are usually very under-tanned, it is necessary at this stage to rectify this, otherwise the leather will not take up sufficient grease, and will

be deficient in solid fibre. Various methods are in use; some people lay the goods in pits with a strong tanning liquor for a few weeks, whilst others are content to give them a brief immersion in sumac liquor, or an hour or two in a good strong tan liquor in a drum-tumbler. In many large works the butts are well tumbled in a mixed tan liquor composed of gambier and sumac, and perhaps myrobalans, for six or eight hours. After this they are then again drummed with a sumac and gambier liquor strengthened up with sufficient good oakwood extract. After this second drumming the butts are washed through a warm sumac liquor to brighten up the colour, and are then allowed to drain for a few hours, when they are hung up to dry. Various machines are in use for ridding the butts of moisture before drying. In some works the hydraulic press is brought into requisition, whilst others use a form of squeezing machine. It is by no means certain, however, that these are an advantage for the purpose, as it is thought by some that the loss of certain solid matters in the tannin leads to a loss of weight in the finished leather.

In the olden days butts were after re-tanning scoured out flesh and grain on the slate table by means of sleaker and stock stone, when they were "sammied," or half-dried, thoroughly stretched or "set" out on a wooden or marble table, and stuffed on the flesh side by applying a liberal coat of dubbin by means of a brush. The butts were then dried out slowly, and then "tallowed" on the grain side, or, in non-technical language, rubbed over on the grain with a slight coat of dubbin. Hand-stuffing has, however, been almost entirely superseded by a method known as drum-stuffing, by which melted fats are mechanically worked into the leather in the tumbler. This is really the most important modern development of the curriers' art, and as such warrants a full description of its technique.

Drum-stuffing.—The successful application of grease to leather in the process of drum-stuffing depends upon a variety of conditions, and much money has been lost

before the various points were fully understood. Even now burnt leather is fairly common, although the introduction of air-heated tumblers has greatly lessened the risks common to the use of steam for the purpose. The modern hot-air drum (see Fig. 70) is now often fitted with a grease melting and mixing pan, and is so arranged that the melted fats are fed automatically into the drum; other tumblers are fitted with both steam and hot air, the former being useful for cleaning purposes. The main advantage about the hot-air tumbler is that it can be rapidly heated and cooled, the latter being often done by injecting cold air.

To return, however, to the *modus operandi* of drum-stuffing. The butts, after drying, are first carefully weighed, and the amount of grease to be used calculated on a percentage of this dry weight. After weighing they are damped down again; not too much water must be given, or the leather will fail to absorb the grease, whilst if the butts are too dry, the risk of burning is great. After the butts are quickly dipped in the water they are laid in pile for a day or two and carefully covered with bagging. This has the effect of allowing the goods to get into better condition, as the moisture becomes evenly distributed. At the end of this time the butts are slightly damped in the dry places with a brush, when they are ready for stuffing.

A good deal might be written on the various materials employed in drum-stuffing, for since it was found hard greases, such as waxes, stearines, &c., produced a better looking and heavier leather, the old-fashioned tallow and cod oil have largely dropped out of the currier's list of materials. However, it will be sufficient for our purpose to give one or two representative stuffing mixtures and their method of application. Generally speaking, the firmer the leather is required the greater the proportion of hard grease, wax, or stearine given to it. In America it is known that as much as 80 to 100 per cent. on a dry weight of the leather is worked in; but English curriers for various reasons do not, as a rule, obtain such results.

In drum-stuffing the drum is first heated up to the proper temperature, say, about 130° to 140° Fahr., when the condensed steam in the form of water should be run off.

In the older form of drum the melted grease was put in, and the damp leather stacked on the shelves, when the door was securely fastened and the drum set in motion. Another and better plan is to put the butts into the heated drum and allow them to run without grease for a few minutes; this has the advantage of heating the leather through, so that when the hot grease is subsequently added it does not coagulate on the surface of the leather and thus prevent its penetration. In the more modern form the grease is fed through the axle of the drum whilst it is in motion. This is a much better arrangement, as it prevents any single piece of leather sticking to the side of the drum and thus only getting partially stuffed. Kip butts should be run in the grease from thirty to forty minutes, after which the drum door is taken off and replaced by an iron grill or grate, and the goods allowed to run another half-hour to cool down. It is best, in order to get this result, to run the goods for a few minutes, and then to stop the drum for another short period, as this prevents the butts from being knocked about too much, and thus parting with a portion of the grease.

As before hinted, no two curriers use precisely the same stuffing mixture, and a good deal of unnecessary secrecy is observed with regard to their composition. In the early days, when drum-stuffing was introduced from America, nothing but cod oil and tallow was used; now the number of greases used is legion. Good curriers claim often to get as much as 50 to 70 per cent. gain on the rough weight of kip butts by the use of such materials as stearine, degras, or sod oil, paraffin wax, and perhaps a little resin. The first mentioned is, of course, the chief constituent, and splendid results are obtained in quality and weight by the use of a stearine of about 100° Fahr. melting-point. One good and representative

stuffing mixture for kip butts is as follows: For 100 lbs. of dry leather take, say, 10 gallons of stearine—or, if tallow is used, say, 50 per cent. more—1 gallon of sod oil, and 5 gallons of degras.

It is, however, of little practical use to give other formulas for stuffing mixtures, as everything depends upon the tannage and the requirements of the market. A great deal must be left to the judgment of the individual, but if the rules and methods given are carefully followed out no loss or difficulty should be experienced. Too much care cannot be given to the choice of good and suitable stuffing materials, and experiments should be carried out slowly at first, and on a small scale, as trouble with leather does not always make itself manifest until after the finished leather has laid in stock for some time.

Setting.—This is an operation which has to be done quickly and thoroughly, so as to remove all stretch and contracted grain. The methods in vogue differ slightly, but as a rule the grain side is first well worked out on a flat table with a stock stone, and the flesh side then well "canked" or extended with a suitable steel sleaker. The grain is then again stoned and glassed with a rounded glass in a suitable handle, and the butts hung up to dry. Some curriers prefer to cank them first, and after stoning the grain allow the butts to slightly samm or dry, and then reset. Some lay them in pile between the two settings, and on the whole the best results perhaps are obtained this way if the damp butts do not lay too long and thus become heated.

In any event, drum-stuffed leather should not lay about in the air long, as oxidation is apt to set in on the exposed surfaces and cause unsightly stains. Machines are now being used for kip butt setting, and once the technical difficulties in the way are overcome, it is only a question of time when hand setting will become extinct.

Special stress has been laid upon the drum-stuffing process owing to its revolutionary character as compared with the old hand method, and also to the difficulty of

obtaining reliable working data upon it. However, we will now assume our kip butts have been carefully dried in the sheds. If this has been carried out without the use of too much artificial heat, they should be of a good colour and not inclined to crack on the grain. If the grease has done its work, very little in the way of rounding or "tallowing" is wanted, although it is better to go through them and apply a little dubbin where it is required. Some curriers lightly brush over the flesh side with dubbin, and allow the butts to lie in pile for mellowing purposes for about a month. The butts are then ready for the final operation of finishing, and as there is practically no grease on the surface of the leather the old process of "making up"—necessary to hand-stuffed goods—may be dispensed with.

Finishing.—Whitening is the first operation, and it is interesting to note that since this book was first written the whitening sleaker has completely ousted the light shaving knife for that purpose. The sleaker is much more convenient to use, and in skilled hands produces a better result, besides taking less weight off the leather. The work is now usually done on a glass or marble table, and if the butts have been properly shaved, it is only necessary for the workmen to just skim off the light nap or fibre which has been raised by the previous processes. The workman, by pressing the leather firmly against the edge of the table with the upper part of his legs, proceeds to take a bold sweeping stroke straight up the butt, and finishes up by lightly skimming over towards the belly edge.

Whitening is greatly facilitated by first moistening the surface of the leather by a weak soap solution; this is easily applied with a brush or sponge, and not only greatly assists the workman, but helps to form a fine and close surface. Good whitening is all-important, and the work should be free from scratches or "stabs," whilst every care should be taken to avoid cutting too deeply into the leather, otherwise coarseness of fibre is unavoidable. In most works the foreman carefully looks over the butts after whitening, casting

out any which are badly done. Whitening is now often done by machine, and good results are obtained by the use of a special cylinder on the shaving machine. The machine shown at Fig. 72 is also used for the purpose.

Stoning and Starching.—After whitening, the butts are stoned and sleaked over on the grain side to remove any adhering grease, &c., and are then often trimmed round the edges with a sharp knife to remove rough edges. The currier then mates each half butt with its proper fellow by examining the marks on the grain side of the leather made before shaving. The butts are also often buffed in places on the grain side if this has not been done before whitening; this is a great improvement to the commoner classes of goods, and removes scratches and broken grain, which, if left, look very unsightly. The butts may at this point be given a weak coat of some mucilaginous solution, to which is added a little colouring mixture, such as anatto or some suitable aniline dye. This operation is technically termed "starching," although the solution used is generally composed of glue and water. After the butts have been hung up to dry, they are ready for graining.

Graining.—This process is fairly simple as applied to kip butts for waxing, for, as a rule, the shoe manufacturer requires the leather firm, so that it stands up boldly in the boot. In most works graining is now done by crossing and recrossing the grain of the leather with a cork-covered pommel, the same tool being used for "bruising" or softening. The old hand-graining board is now only used for the lighter kind of leathers, such as sheep and goat skins, a heavier and much more serviceable tool, called the "arm board," being used for graining kip butts.

Graining is so well understood that it is not necessary to again take up space by describing it; the primary idea is to somewhat soften the leather, whilst the operator should endeavour also to develop a small neat figure, such as one is accustomed to see on grained calf skins.

Naturally the workman pays most attention to the hard and close parts of the butts, as the less pressure put upon the belly and shoulder parts the better, owing to the comparative looseness of the fibre.

At this point the leather is for all practical purposes well curried and ready for the final operation, although some curriers prefer to apply a light soap solution, which is well glassed into the flesh side before the butts are passed on to the waxing-room for the final blacking and sizing. In this state the leather is said to be "in the russet," and it is in this condition the famous French tannages of calf skins are exported, the final blacking being put on in England or elsewhere.

Waxing.—Here, again, every waxer has his own particular methods and ideas; the principle involved is, however, very simple, the idea being to produce a good and deep black on the leather, with a modified gloss which will stand the somewhat severe handling of the shoe manufacturer. Some waxers use a sort of weak paint composed of cod oil and lamp-black, to which a little weak sumac liquor is added to facilitate matters, whilst others prefer a soap solution as a medium for the colouring matter. The soap colour is, perhaps, the most useful, as it helps to produce the great desideratum of the currier—a fine and smooth surface. With this colour, too, there is no danger of darkening the leather, as is often the case when oil colour is used in a warm room by a waxer who is anxious to show a good grain of weight. But whatever colour is used only enough should be applied with a brush to give a good black, or it will be difficult to remove the excess of "smut" or solid matter. This is usually done by rubbing over the leather with the hand or a suitable brush, and is a very necessary section of the waxing operation. After smutting, the butts are usually again glassed and are then bottom sized, *i.e.* given a weak coat of a properly prepared compound which is well rubbed in with a glass tool. The composition of bottom sizes varies greatly, but the following are practical, and if

modified to suit individual cases will be found very useful:—

1 lb. best glue;
1 „ flour;
8 oz. soft soap;
4 „ sugar of lead.

The whole of the materials are first dissolved in seven or eight pints of logwood liquor, and incorporated by stirring during cooling.

Another bottom size is prepared thus:—

10 pints of logwood liquor;
1 lb. best glue;
1 „ flour;
½ „ soft soap;
¼ „ sulphate of copper ("bluestone").

Whatever bottom size is used, care must be taken that it is used sufficiently weak, or trouble will certainly arise when the final top-sizing is given to the leather. In practice it is usual to first try both sizes experimentally, and weaken down with water or a little dubbin if found too strong.

Top-sizing.—After the bottom size has been well glassed in and allowed to dry, the butts are then top-sized. Only sufficient should be given to nicely cover the leather, a special brush being used for the purpose. After the composition has been applied, a fine smooth surface is obtained by finally rubbing the still damp surface with a leather-covered pad or a bare arm, the aim being to obliterate the brush marks. The butts are then hung up in a heated chamber and allowed to dry. A final glassing and oiling with warm cod oil completes the process, and if the methods outlined have been followed out, a saleable article should be the result. If the sizing has been well done with suitable materials, the surface should improve with age, whilst the size should become tough,

and possess a "bloom" which is appreciated by buyers of this kind of leather.

Before closing this chapter it may be as well to give a typical top size for waxed leather. This may, as before hinted, want slight modifications to suit individual requirements, but it will be found a good working formula, and as such worthy of note :—

1 lb. best glue;
10 pints of logwood liquor;
2 pints cod oil;
2 oz. beeswax;
6 shoe-finishers' heel-balls.

The glue is first soaked in a part of the logwood liquor and then slowly dissolved by heat; the other ingredients are also dissolved in a separate vessel and added to the glue solution; both solutions should, of course, be first carefully strained through a fine muslin cloth. Care must be taken to keep the size stirred during the cooling process, otherwise the final result will be unsatisfactory.

Another recipe: 1 lb. kid clippings; 7 pints water; 1 lb. glue; ½ lb. soft soap; 4 ozs. beeswax; 2 pints cod oil; ½ lb. tallow; 4 ozs. Venice turps; 2 ozs. prepared asphaltum. Prepare and mix as above.

In conclusion, it should be said that the manufacture of wax kip butts has been gone into fairly fully, as their manufacture represents the modern development of currying, and illustrates better than any other leather how old-fashioned methods have been grafted on, as it were, to the use of machinery and modern methods. The trade is still a very large one in these goods, and as the leather possesses qualities which are difficult to obtain in other leather, whilst the supply of raw material is likely to continue fairly abundant, it may be safely assumed that not even the chrome industry will ever supplant this valuable section of the orthodox currier's art.

Currying Satin or Glove Shoe Leather. — Under various names a variety of most useful leathers are now

finished on the grain side. Satin leather has long been included amongst British curried leathers, and satin calf used to be highly esteemed. The term "satin" is sometimes applied to a leather finished on the grain, the surface of which has not been removed or buffed, whilst "glove" shoe leather is usually understood to mean a leather which has had the grain removed: both terms are, however, used in a somewhat arbitrary manner. It is claimed for the buffing process that it adds to the wear of the leather, as the hard natural outer surface of the dermis soon becomes hard, and ultimately cracks. On the other hand, it must not be forgotten that buffing immensely improves the grain of the tanned leather by obliterating barbed-wire scratches, frized grain, and other imperfections which curriers are painfully familiar with.

It may be mentioned here that the trade in glove hide has assumed enormous dimensions, mainly owing to the enterprise of the Americans, who, by the employment of machinery, and perhaps a highly protected home market, have been enabled to sell this leather at a very low price. The American tanner, by specialising on side leathers alone, has a decided advantage over his European competitor, who is perforce obliged to handle not only kips, but shoulders and bellies of different sizes and substances for satin purposes. However, a good trade is still done in grain leathers, and in the following summary it is proposed to give an outline of the various processes employed, which, although varying in different works, yet depend on much the same principles.

Soaking and Splitting.—These operations are carried out in precisely the same way as in the case of kip butt dressing already described. In the case of the lighter classes of kip offal, shaving only is necessary, which may be either done by hand or machine. It might here be mentioned that thin kip shoulders and bellies are often dressed and blacked on the grain side, and are commonly called "black grain;" in this case, however, the outer surface of the grain is not buffed away as in glove.

As a rule, it is only the stouter and rougher classes of

hide offal, or sides, which are worked up into satin or glove, and as the leather is full in substance, it is well adapted for splitting, whilst as the flesh split is also valuable, it is obvious the saving is great. As before hinted, successful splitting depends upon a proper preparation of the leather, and too much care cannot be taken in arriving at the proper amount of moisture it should contain, or in the careful treatment of the leather before the actual splitting commences. It is usual before splitting, and after damping, to thoroughly extend the leather by means of a suitable machine; this has the effect of removing coarse grain, wrinkles, &c., which would leave unsightly marks in the finished leather. This object is obtained by stoning, or "jacking," out the grain side of the leather on a machine of the grasshopper type, such as is illustrated in Fig. 77. Small curriers usually have a set of interchangeable tools for this piece of plant, and amongst them a stout brass or stone sleaker, which is very useful for preparing work for the splitting machine.

Much might be written on proper splitting, but no amount of instruction will possibly make an expert splitter, who, by the way, is an invaluable adjunct to any leather works. Glove leather is now invariably split on the band-knife machine, and a good splitter is able to get his leather sufficiently uniform to avoid any subsequent levelling with the shaving knife, although it must be acknowledged that for some classes of goods this latter operation is an improvement. Two much care cannot be taken by the operative in splitting, since any damage done is permanent. He should frequently examine the leather as it passes through the machine, and immediately rectify any errors in substance. The knife should also be kept constantly sharp, and the bevel most suitable to the grade of goods under treatment fully kept up. Precautions must also be taken to guard against the flying emery dust from the grinding apparatus coming into contact with the leather, or a good deal of discoloration will be the result. As a rule, a smart boy attends the splitter,

and removes the leather as it comes through, the splitter carefully feeding the leather on the other side. In America the position is reversed, the chief operative being the one who takes the leather from the machine. In America, however, several splitting machines are under the charge of one man, who is really responsible for the quality of the enormous quantity of work turned off by the machines. Another point about splitting worthy of note is the necessity for a sharp removal of the goods after the operation. It is a common fault to see leather being left about near the machine for workmen to walk on, or to catch the flying particles of emery from the wheels. The machine, too, is well worth attention in the way of extreme cleanliness, and it is a good rule to see that every part is thoroughly wiped dry and rubbed with an oily rag after the day's work.

After splitting, kip leathers are first re-tanned much in the same fashion as described in the previous chapter. Hide leathers, being fully tanned, do not require this treatment, and are usually given a sumac bath in the drum. This considerably mellows the leather, and enables it to take a much greater quantity of grease in the subsequent stuffing processes than would otherwise be the case. After sumacing, the goods are scoured either by hand or by one of the many scouring machines. As the leather is to be blacked on the grain side, the removal of the bloom is not of great importance, so that the scouring may be pushed forward rapidly. After scouring, the leather is either taken to the sheds for hand-stuffing, or dried out if the process is to be done by the drum. Of late years the former process has almost become extinct in the larger establishments, owing to the cost and the impossibility of getting in the weight as compared with drum-stuffing. We will assume, then, drum-stuffing is the process to be followed out. It will not be necessary to again go into details, as they were fully described in the chapter on Butt-dressing, but it cannot be too often insisted upon that the greatest care is necessary in the application and selection of the various greases if best

results are to be looked for. Some curriers make the mistake of supposing that any old grease is good enough for satin or glove leather; but it is hardly necessary to say the results are by no means as good as when good fats, such as tallow or stearine, are used. The amount of grease put into the leather varies a good deal, but may be probably put at about 60 to 70 per cent., calculated on the dry weight of the leather. Of course the whole of the melted grease put into the stuffing-drum is not absorbed, although a good currier loses very little. The gain of weight in America is very much greater than in England, as much as 90 to 100 per cent. being obtained on the weight of the dry leather. This result is, however, largely obtained by the use of hard stearines and waxes, whilst the fact that the hemlock tannage is a good grease absorbent is probably an important factor in its favour. In stuffing satin leather the drum is heated up to about 140° to 150° Fahr. before the leather is entered, whilst it takes about thirty or forty minutes for the melted fats to be absorbed by the leather. After cooling down, as already explained, the leather is set. In many places this is done wholly or partially by machine, although if the latter plan is favoured, the work has to be gone over again by hand to remove the marks remaining. The leather has to be in any case very fully extended both on the flesh and grain. If this is not well done, the grain is coarse, and the leather will probably be pipey and loose, to say nothing of the greatly increased difficulty which the buffer will experience in the removal of the outer surface. The leather is then dried in the ordinary way.

Buffing.—Although this may be done by machine, yet the process is so difficult that most curriers prefer hand-buffing. Even the progressive American currier has not yet fully conquered the question of machine buffing, although the problem has had the serious attention of engineers for many years past. Still, for some requirements a machine does the work well enough, and a machine of the type described in the chapter on Machinery (see Fig. 72) is often very useful for the

purpose. A long description of the machine is not wanted here, but, roughly, it consists of a cylinder containing an arrangement of spiral knives fixed at the end of a pendulum, or vibrating arm, the whole arrangement being worked over a sloping table. The leather under treatment is laid over the sloping table, which is automatically raised to meet the action of the cutting cylinder by means of a foot lever. As a rule, machine-buffed leather has to be gone over again by hand, as the machine is apt to miss the thinner parts of the hide.

In hand-buffing the whitening sleaker is used, and only expert workmen are trusted with the operation. The grain is first damped with a soap solution, and the buffer takes off very thin shavings from the surface. Great care should be taken to avoid scratches, stabs, or "run" marks; otherwise the finished leather will be unsightly and of lower value than would be the case with good work.

Blacking and Setting.—After the buffing operation, leather for glove or satin is then blacked. Different curriers have different methods; some mordant the grain with a logwood solution, and apply the striking iron liquor at once. The leather is then well set out on flesh and grain, and after the latter had been dried, a solution of some filling material is applied with a soft sponge. For hide sides the following methods may be taken as fairly representative, whilst it also obviates to some extent the tendency toward pipey grain before alluded to. Brush over the grain with a weak solution of logwood liquor (about $\frac{1}{2}$ lb. to the gallon) to which has been added a little ammonia. Then well set out the leather on the table, which has previously been rubbed over with tallow to make it stick. Care should be taken to give the side a good pattern, and this is only to be obtained by the workmen using the setting sleakers by following the natural lay of the hide. After this setting, the leather is again washed over with the logwood liquor, when a coat of some suitable ink or iron liquor is given. The sides are laid by in a pile, and are then thoroughly

canked on the flesh side, the grain being this time stuck to the table by the use of oil. After this the sides are again set on the grain side to the table, a coat of dubbin being first brushed on to the latter. After a further sleaking, to remove surplus particles, followed by a glassing or pebbling, a coat of paste or bottom size is applied with a sponge or brush. Various mixtures are used, but the following will give excellent results, viz. a quarter-pound each of best glue, oil, and flour, mixed in about two quarts of hot logwood liquor. This is a representative formula, but different tannages require varied pastes and sizes, and often want a good deal of modification to suit individual requirements.

Finishing Satin or Glove Leather.—After drying out, the leather is now whitened; in some places this operation is done by machines, as they are quicker in their action than hand labour. The same class of appliance as that spoken of for buffing does whitening fairly well, although opinions as to its merits vary considerably. If the leather is to be whitened by hand, a slight skiving over with the sleaker is sufficient, as in this case it is only necessary to clean the flesh side for appearance' sake. When the leather is whitened it is then trimmed at the edges, and lightly bruised with the arm-board to soften it. This operation is, of course, done from the grain side so as to avoid raising the grain; it requires care and judgment, and very little pressure should be given to the coarse and loose part of the hide. Satin is then again sleaked down on the grain side with a dull sleaker to remove the bruising marks, and glassed or pebbled as preferred. The leather is then given a coat of finish in a warm room and dried out very thoroughly. Some people who prefer a dull finish use either a flour or gum solution, a few drops of ammonia being added to it if any difficulty is experienced in its application. A good finish may be prepared as follows: In 4 quarts of logwood liquor dissolve 1½ lbs. of glue, 4 ozs. of brown soap, 3 pints of cod oil, and 2½ ozs. of beeswax. This is applied with a suitable pad covered with cotton wool, over which is tacked a

piece of buffed leather. Extreme care must be taken to avoid marks of any kind in the application of the finish, as it is impossible to remove them later. The leather after thoroughly drying is now again glassed, oiled with warm cod oil, again hung up until the oil has penetrated, when it is ready for the finished-leather store-room.

Satin or glove leathers, it is true, do not now enjoy the popularity they did before the introduction of the chrome tannage. Still, the trade is yet a good one; and as the leather is extremely useful for such work as the cheaper grades of women's and children's footwear, it is very unlikely it will ever become obsolete, and there is no reason, if the above directions are carefully followed out, why the reader may not get good results on this class of leather, even if he has not been accustomed to this special work.

Levant Leather.—Until the advent of chrome leather the levant trade was a most important branch of the leather-dressing industry, and even now kip curriers still find it a useful addition to their business. The term "levant" is usually applied to an embossed or printed leather, finished on the grain side with a bright surface, and dressed with oil only, *i.e.* not stuffed with fats and greases as in the case of waxed leathers. This section of leather manufacture provides a very useful outlet for poor goods unsuitable for wax and satin, and very little hand labour is required under modern conditions.

Soaking and Splitting.—Taking East India kips as an example, the process is as follows: They are first carefully soaked until the water just oozes out on sharply pressing, and after lying in pile for a few hours they are softened by a short drumming, and are cut straight down the centre of the back.

They are then split evenly on the band-knife machine, and are either first scoured or taken away for retanning. This is invariably done in the drum, a mixture of sumac, myrobalan, or gambier liquor being used, often strengthened with a certain proportion of good oakwood extract. This retanning is an important part of the

levant business, as India kips are very often undertanned, and if this is not reckoned with, the finished leather will be hard, and will refuse to take the necessary quantity of oil to make it profitable.

Setting, Buffing, and Embossing.—After drumming for about eight hours, either drain up the goods thoroughly, press or squeeze by machine, or strike them out on the flesh side. Then take them to the drying sheds and lightly oil with linseed oil on the grain side and hang up to samm. They are then well set by means of a sharp sleaker on the flesh side, and hung up and dried out, a little oil being used to stick the kips to the table.

When fully dry go carefully over the grain side, and carefully buff all broken grain, first slightly damping the surface with a sponge and sleaking the place to be buffed well first with a dull sleaker. After buffing where necessary, sort the kips for printing, throwing all those inclined to be "pipey" or coarse-grained out for the heavier style of print, such as seal or big-star grain.

The embossing or printing is now usually done by means of a suitable engraved roller (see Figs. 81, 82), the entire side being subjected to a fair pressure in passing through the rollers. A better impression is obtained if the leather is first damped slightly. The kips are then dried out, and may be stored in this condition until ready for finishing.

Blacking.—The goods are now dried out after all the pleats made by the machine are carefully trimmed out, or remedied as far as possible by going over them with a small hand roller, the design being of course similar to the large one used in the first place. After embossing, the next process is the blacking operation. This is done by giving the grain side a coat of logwood decoction, and subsequently another coat of levant ink, care being taken to keep the flesh side as clean as possible. When trimmed the kips should be well softened and grained: This is now almost always done by the boarding machine,

the bulk of the work being done to the flesh side to prevent piping (Fig. 71).

Seasoning and Glazing.—After this softening the goods are seasoned, care being taken to have the seasoning material well brushed into the grain. A suitable seasoning is composed as follows: 6 pints of bullock's blood; 4 pints of logwood solution; 2 pints of blue archil solution, and $\frac{1}{4}$ pint of spirit of wine. When the season has well dried into the leather, have the kips again well grained, taking special care that the design is made as perfect as possible and that "piping" is avoided.

A second seasoning is then applied composed of the following ingredients: 7 pints of blood; 4 pints of logwood; 2 pints of new milk; 1 pint of archil liquor; $\frac{1}{2}$ pint of spirit of wine; and 2 ozs. of burnt sugar.

After the goods have been well dried they are usually fluffed on an emery wheel to clean the flesh, and are then ready for glazing. It is best before taking them to the machine to slightly wipe them over with a rag dipped in linseed oil, as it helps to prevent dragging or scratching under the pressure of the glazing-glass or agate. The machines in use are many, but those of the type shown in Figs. 77 and 78 are representative. After glazing, the goods are again carefully grained, the pattern being carefully preserved. This requires a good operator, as it is impossible to rectify mistakes made in this final graining.

Oiling.—A final oiling now completes the process. This is applied with a suitable wad or flannel rag, the oil being warmed and spread evenly over the surface of the grain. Linseed or mineral oil is used for the purpose, according to the quality of the goods. Sometimes a mixture of both is given, whilst others oil off solely with the cheap mineral product.

Care should be shown in the oiling, otherwise, if too much is given, it will penetrate to the flesh side, and spoil the appearance of the finished leather. The kip sides are now sorted into qualities and substances, and are ready for the shoe manufacturer.

Currying Various Leathers. Wax Calf Skins.—From an interesting series of articles upon currying which appeared some years ago in a technical journal, now extinct, we make the following extracts, as they illustrate the difference between the new methods described in this chapter, and the old ideas on which they are based :—

"Calf skins of various weights (tanned), from 2½ lbs. to 8 or 9 lbs. each, are curried for shoe purposes. Light skins should not be shaved so much as heavy ones; the flesh should merely be taken off and the veins taken out, so that they may be level in the butt part, being first of all shaved over; they do not require flattening except they are lumpy—that is, thicker in one part than another. After they are shaved, scour, flesh, and grain, give them a good sumacing, and let them lie for a day or two. Warm the liquor before they are sleeked out of that; stiffen them a little in the shed. If they are not very coarse in the grain they need not be set on the grain at all, as it will be found that it renders them much softer and more after the style of French skins. Before stuffing, put a little oil or dubbin on the grain, turn over, and sleek them on the flesh, then put the dubbin on the flesh and hang on two loops in the shed to dry. When dry, take down and put a little dubbin on the grain, commonly called 'tallowing,' and lay them aside for a few days. Heavy skins require more shaving than light ones, and therefore take more dubbin. After they have lain by, if heavy skins, slightly raise the grain with a toothboard or cork. Sleek the grease off the flesh and grain, and whiten them with a turned sleeker or knife, whichever the dresser uses best. Bruise on the flesh and grain up, then wax them. The process of waxing is to colour on the flesh—that is, to put black on the flesh (lampblack and oil). Now glass down on the flesh, and size on the same side; hang up for the size to get quite dry, then glass on the same side.

Calf Skins for Memel weigh from 30 to 40 lbs. per dozen. These are shaved level, scoured flesh, and grain, care being taken not to injure or break the grain; they do

not require much sumacing, if well tanned. Sleek out on the grain and hang in the shed to samm; when stiff enough, set them on the grain, and print them with a memel or straight-grain roller. Oil on the grain, turn over, and lay flat on the table; but do not set them on it. Stuff them on the flesh; but they do not require so much stuffing or dubbin as wax leather; now hang up to dry. Some persons have them printed after they are blacked, others will not have them printed at all when dry. Next take them down and black on the grain side, and size; when well hardened, slightly grain up, and put them in the stove or drying-room; when dry, clean the flesh side, and finish graining, then oil with linseed oil, when they are ready to cut up.

High Shoes, Black Grain.—These are mostly cut from the best part of the hide, free from cuts on the grain side, and must not be shaved so low at the bottom part. Scour flesh and grain, compo if desired, as it renders them soft and pliable, and they take more stuff; now hang in the shed to samm; set on the grain, if required, oil, and print before stuffing, with a straight or cross-grained roller. Turn over and stuff on the flesh side; they will generally take twice as much stuff as wax legs, in fact you cannot give them too much. Now hang in the shed to dry, and when dry, black on the grain and oil. When the oil is absorbed, raise the print with a cork or toothboard, then hang up in the drying-shed; before doing so, however, they should have a coat of dubbin on the grain, if they have lain by for some time. Sleek the grease off the flesh, bruise the flesh, grain up and give them a good coat of clear oil on the same side: they are then fit for use.

Split Cow-Hides for Brown Bags.—These are shaved lightly on the flesh side until they are level; they are then scoured, flesh and grain, and sumached; next sleeked out of the sumac; then put into the shed to samm, and when stiff enough are printed on the grain. Stiff tallow dubbin is laid over the grain, buck or deer tallow being preferred. Stuff on the flesh if desired, otherwise slightly glass down on the flesh, and hang up to dry. After

drying, raise the print, and bruise on the flesh. See that this side is free from grease, then glass the same side, and brush the grain with a good hair-brush, when they are ready for sale."

Blocking Boot-fronts.—This operation, which was formerly conducted by the bootmaker, sometimes forms a

Fig. 59.

branch of the currier's business. For the following description of the *blocking-machine,* and the method of

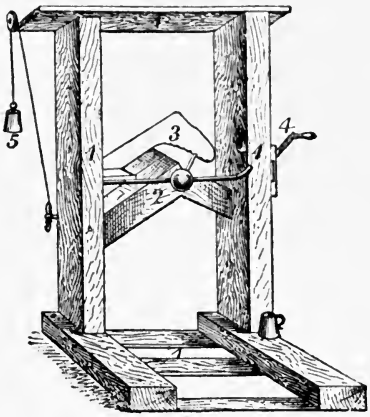

Fig. 60.

working it, we are indebted to Ure's "Dictionary of Arts, Manufactures," &c. The leather, being dressed as before described, is cut out as at *a*, Fig. 59, and when folded or doubled, appears as at *b*.

In Fig. 60, 1 1 1 is a strong frame of woodwork; 2

represents a pair of cheeks, strongly fastened in the frame, and regulated to a *distance* by a screw. These cheeks are lined with zinc. 3 is a strong plate of metal, the angle at 3 corresponding exactly with the angle of the cheeks; the ends of this plate are fixed in movable plates passing down the columns 1 1; 4 is a handle by which the instrument is worked, and which, by cog-wheels acting on the movable plate, brings 3 downwards. The front *a* is laid, after a thorough soaking in water, over the cheeks 2; the handle being turned, 3 comes down upon the front, and forces it through the small opening between the cheeks, and when brought out below the cheeks it has the appearance given at *c*. The plate 3, having carried the front between the cheeks,

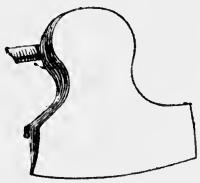

Fig. 61.

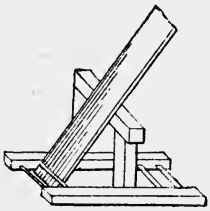

Fig. 62.

is removed (below), and the weight 5 assists in bringing the perpendicular movable plates to their place, when 3 is again put in position, and thus the operation is rapidly carried on. After this the *fronts* are regularly placed on a *block*, being forced into position by an instrument called a flounder (Fig. 61), and tacked to their place. After this they are slightly oiled and dried. Some ingenious methods have been adopted for softening fronts so as not to disturb the *blocking*. They are whitened on a very sloping beam or horse (Fig. 62), which enables the workman to hold them better than he could on the common beam. They are again blocked by the waxer, and when these processes are carefully performed much trouble is saved to the bootmaker.

CHAPTER XXXI.

MACHINERY EMPLOYED IN LEATHER MANUFACTURE.

"Stocking" or Softening Machines.—Depilation and Fleshing Plant.—Machines for Crushing and Grinding Tanning Materials.—Solo Leather Finishing Machinery.—Leather Dressing Machinery.—Scouring and Setting Machinery.—Embossing and Softening Machinery.—Tanning and Stuffing Drums.—"Boarding" and Softening Machines.—Machinery used in Chrome Leather Manufacture.—Machinery used in the Beam House.—Finishing Machinery for Chrome Work.

During the past few years the use of mechanical aids has greatly increased in every department of the leather trade. True, the British tanner is not so enthusiastic over their adoption as his hustling American rival, as he has to deal with smaller quantities and more varied lines of goods; in a word, he has not the opportunity of specialisation common to the United States. On the other hand, it must be admitted that many of the best machines had their origin on the other side of the Atlantic, and that they have only been adopted in other parts after the progressive American had, by long and costly experiment, proved their utility. The inventiveness of the native American, and the readiness of tanners to take up new ideas, have been important factors; in short, a variety of causes have favoured the transatlantic machinist, the cost of skilled labour being, perhaps, amongst the most important.

Of late years, however, a good deal of tanners' machinery has been made in England and the Continent, and there is now very little to choose in quality or price between

the various makes, although the Americans admittedly do not put so great an amount of finish into their work. Naturally, the greatest chance for the leather trades' engineer has been in the direction of the lighter leathers, and there is no doubt but that the introduction and exploitation of chrome leathers has proved his great opportunity.

The cost of machines suitable for sole leather tanners and their enormous capacity have made it somewhat difficult to successfully push this class of plant. Until quite within recent times many of the sole tanneries have been on a very small scale; modern competition is, however, gradually proving too strong for them, and the industry is drifting into larger hands. Stronger tanning materials have also taken the place of the British oak-bark, and to-day there are many large tanneries in the Warrington and Liverpool districts with a capacity of one to three thousand hides per week. Such yards as these can, of course, profitably employ machinery, and the persistence of the leather trades' engineer is thus slowly, but surely, having its reward. It will be impossible, in the space at our disposal, to explain or enumerate all the various machines now employed in light and heavy leather manufacture, but enough will be said to enable the reader to become *au courant* with the most important developments introduced within the past few years.

Machinery used in Sole Leather Tanning.

"Stocking" or Softening Machines. — The old-fashioned plan for softening the soaked hide was to "break" it over on the half-round tanner's beam with a blunt knife. This plan is still followed out in small yards, and in countries where labour is cheap and plentiful. This method is now supplemented or superseded by the use of the "stocks." This machine consists of a metallic box, in which rise and fall two heavy

hammers, raised alternately by projections in a revolving wheel. The action is very effective, being a sort of kneading or pounding, and the most obstinate hides give way to the treatment. The duration of stocking varies from ten minutes to half an hour. The ordinary form of stocks in use for softening Indian kips, China, "flint," and other stubborn hides is shown in Fig. 6, p. 111. A more modern device, which claims some advantages,

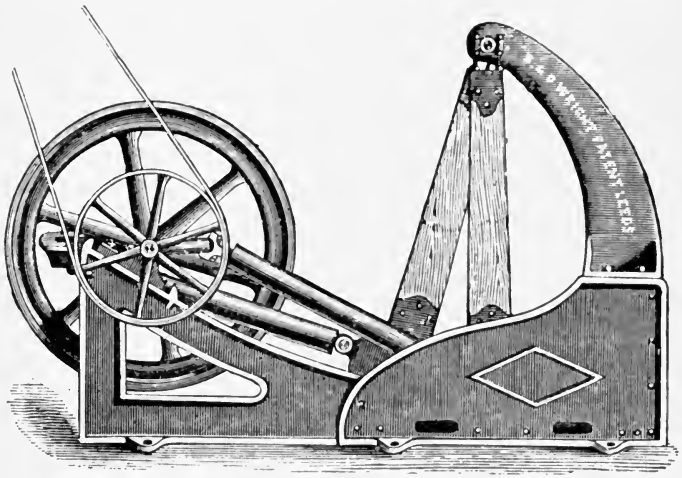

Fig. 63.

is the American double-shover, the principle of which is shown in Fig. 63.

There are other forms of stocks upon the market, but the above two examples give a fairly accurate impression of the main principle involved.

On the Continent of Europe a machine of a somewhat different type is used, which possesses the advantage of being lighter in its action upon the thinner parts of the hide. The idea is simple, being that of a pair of rollers pressed together by a spring. One roller is studded with blunt pegs, which corresponds to grooves in the other,

and so arranged that the hide is subjected to a very thorough kneading.

The method of stocking and softening varies very much in nearly all yards, but in spite of the march of engineering improvements, the stocks remain much the same in principle as in the day when the tanner probably borrowed the idea from his cloth-making *confrère*. For the lighter kind of skins, drum tumblers are effective for softening; but it will be more convenient to deal with light leather machinery under a distinct heading.

Depilation and Fleshing Plant.—After the preliminary softening and cleaning, the hides intended for sole leather are then ready for some process which will swell the pelt and loosen the hair so that it can be easily removed. The most common method is to immerse the pelt in a lime solution, which not only loosens the hair and swells the hide, but converts the fat it contains into a lime soap, at the same time so loosening the cutaneous tissue that the surplus flesh is easily worked off. Other methods of unhairing depend upon the use of sulphides, and putrefaction, technically termed "sweating." By whatever means, however, the hair is loosened, it is usually removed by hand, as the labour involved is not costly; and so far attempts to do the work by machine—at any rate on the heavier hides—have not been particularly successful, owing mainly to the fact that it is generally necessary to supplement the machine work by hand labour, as it is often difficult to remove short hair, or that from patches where the pelt has been insufficiently softened. Much, however, depends upon the requirements of the market and the output of the yard. The principle of many of the various unhairing machines consists of a rapidly involving cylinder, fitted with spiral blunt knives, working over another rubber-covered cylinder, the hide being fed or introduced between the two. The Turner Tanning Machinery Co., Peabody, U.S.A., and Leicester, Eng., have a machine upon the market large enough for sides and whole hides, which is shown in Fig. 64. It is claimed by the inventors

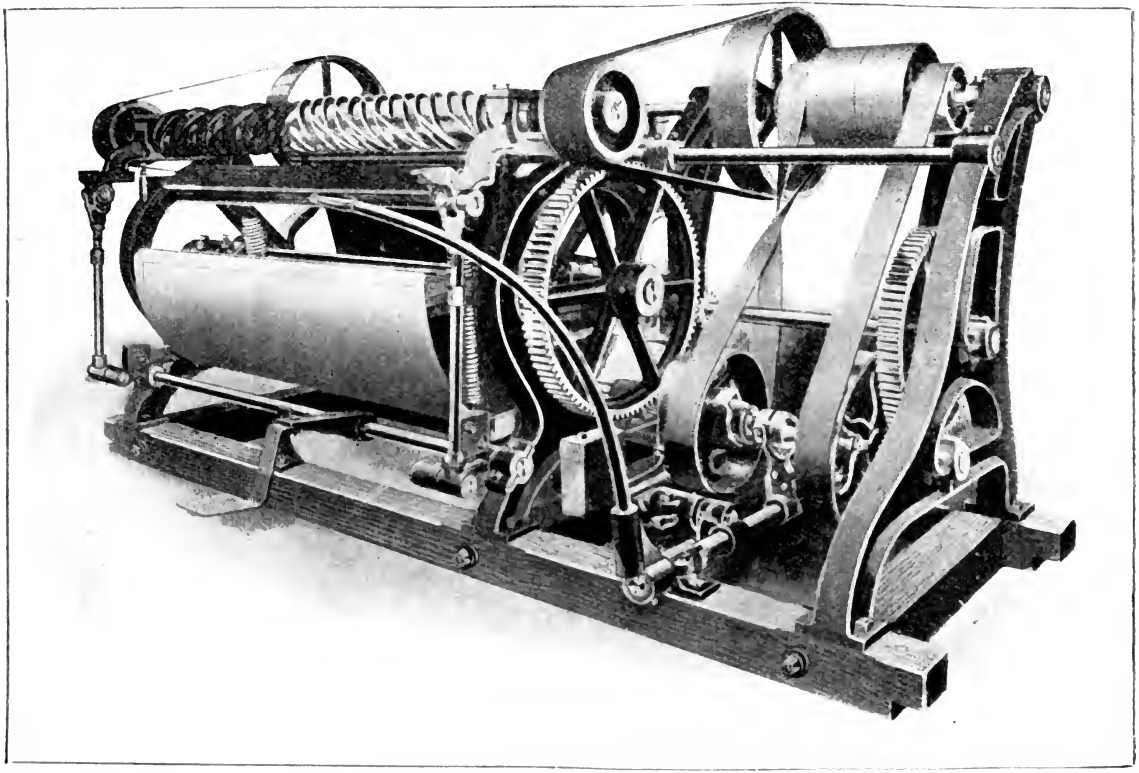

Fig. 64.

of this machine that many hundreds of them are in operation in the largest tanneries in all parts of the world for unhairing, fleshing, and general work in the beam house. The cost of big machinery is naturally great, and the expenses of running fairly so; it is therefore obvious that an appliance of this kind is only profitable in large tanneries.

Much the same criticism might apply to the operation of fleshing, which invariably follows unhairing. It is questionable whether any machine has yet been invented which will give cheaper or better results on hides than the old plan of paring off the loose flesh by the use of a sharp knife on the half-round beam. Machinery, it is true, does the work rapidly, but a certain amount of damage is inevitable, whilst it is difficult to do the work uniformly. In the case of calf, goat, and sheep skins, fleshing machines are used with great success; in fact, hand fleshing has been displaced almost entirely in the large chrome tanneries, as machine work is cheaper and more regular in output. It must be remembered, however, that all sole leather is invariably sold by weight, so that the intelligence of the skilled workman is very useful, as much unnecessary tissue may easily be cut away by machine, with the result that the slight saving in labour may be swamped in the deficient weight of the finished leather.

It is, however, only fair to add that there are several large sole leather yards turning out a good mixed tannage of sole leather which now use the fleshing machine very successfully, so that it is probable it is only a question of time when the old beamsman will become a thing of the past. Improvements are being continually introduced, and the prejudice against the use of machinery passing away, whilst the unceasing competition of the times naturally favours the application of any piece of plant likely to cheapen a process which is of a very costly nature.

Machines for Crushing and Grinding Tanning Materials.—As this chapter does not profess to deal with the technique of tanning, only as far as is necessary in explaining the use of machinery, no attempt will be

made to describe the tannins in detail. Most of them, however, require some preparation by machinery in the way of breaking or grinding by means of bark mills or disintegrators. The object is to grind the material so that the liquor has ready access to the interior cellular tissue, in which most of the tannin is found. The bark mill in general use consists of a toothed cone working inside another similarly constructed cone, arranged much on the same principle as a coffee mill. A preparatory breaking by a special machine is also necessary where the bark to be ground is in long strips, and this is usually done by means of toothed breakers. A common form of mill is constructed by the well-known Exeter firm of Huxham and Browns, and B. and D. Wright, Leeds. An improved bark cutter is made by the Turner Machine Co., Peabody, United States, and is durable, simple, and effective; and it is claimed by the inventors that it will prepare forty cords of bark per day for the leaches.

Such materials as valonia and myrobalans are usually broken by means of the machines known as disintegrators, such as are used to pulverize bones, &c. The principle is simple, and depends upon knocking the material to powder by the action of rapidly revolving beaters, which in some cases are driven at a speed of between 2,000 and 3,000 revolutions a minute. This class of machinery is very effective, but the consumption of power is rather great, whilst the fine dust is apt to prove troublesome. For some purposes myrobalans are only required roughly crushed by the tanner. In this case a machine with fluted or toothed rollers is more useful than a disintegrator, as less power is required and the proportions of dust is very little. Valonia—a species of large acorn cup from Southern Europe—may also be satisfactorily crushed by this class of machinery. The most common form of disintegrator is shown in Fig. 65.

Many other varieties of devices for preparing tanning materials are also in vogue, but the examples mentioned fairly represent the general principle on which most of them are constructed. In England machinery is not

much favoured for carrying tanning material to the leaches or extraction pits, but in America "conveyors" of various kinds are freely used. These consist often of endless iron chains carrying wooden cross-bars at intervals, working along suitably constructed spouts. As the use of conveyors is only profitable in large tanneries where labour is dear, and, furthermore, their

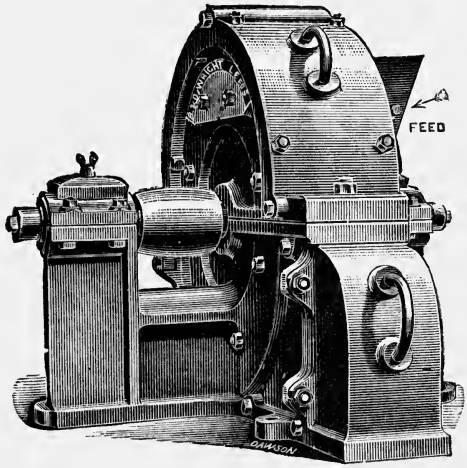

Fig. 65.

design has already been explained on p. 161, it would serve no useful purpose to here further enlarge upon them.

Sole Leather Finishing Machinery.—Sole butts after tanning are usually drained of surplus liquor, and then are given a coat of oil on the grain side and allowed to partially dry, and are then "struck" or "pinned" out. The object is to stretch and render the grain even, and often to scour out as much bloom—a whitish deposit left in by tanning—as may be desirable to suit the requirements of the market. Many tanners of best quality oak-bark leather still persist in doing this by hand, using a

triangular tool called a pin, and thoroughly extending the leather over a horizontal beam or "horse."

Of late years, however, machinery has been successfully introduced for the purpose, and nearly all the biggest English yards employ various types of machines for striking. The most popular form of machine for striking offal is that invented by Priestman some years ago, the principle of which remains the same, although improvements have been added from time to time. A common form of this appliance is shown in Fig. 20, p. 165.

The principle is simple, and consists of a revolving cylinder, to which are attached V-shaped blunt brass knives, under which the leather is fed. The pressure is regulated by a foot-lever acting on a movable bed. The amount of work turned off by this machine is very great, but it is not very well adapted for irregular-shaped pieces of leather, such as bellies, &c.

Many tanners now use the striking machine for butts invented by Wilson (Fig. 66), which is perhaps as near an approach to hand labour as can be obtained. The leather is carried over a revolving drum, and the grain is operated upon by blunt knives working outwards from the centre. Where it is necessary to remove the bloom, slabs of stock stone are substituted for the knives. This piece of plant has been running for many years in some yards and has proved a valuable help, as the cost of striking is nothing like so great as hand labour. It is, however, more especially useful to large tanners, as the first cost is fairly high, and it requires a firm foundation, the oscillating motion being rather pronounced. A modification of this type of machine is also now freely used for pinning offal.

Sole leather, after lightly oiling and drying, is then submitted to a rolling operation to give it the necessary solidity and firmness. On the Continent a different method prevails, and the leather is well hammered by a machine known as the Marteau-a-battre, the action being much the same as that of the well-known steam hammer.

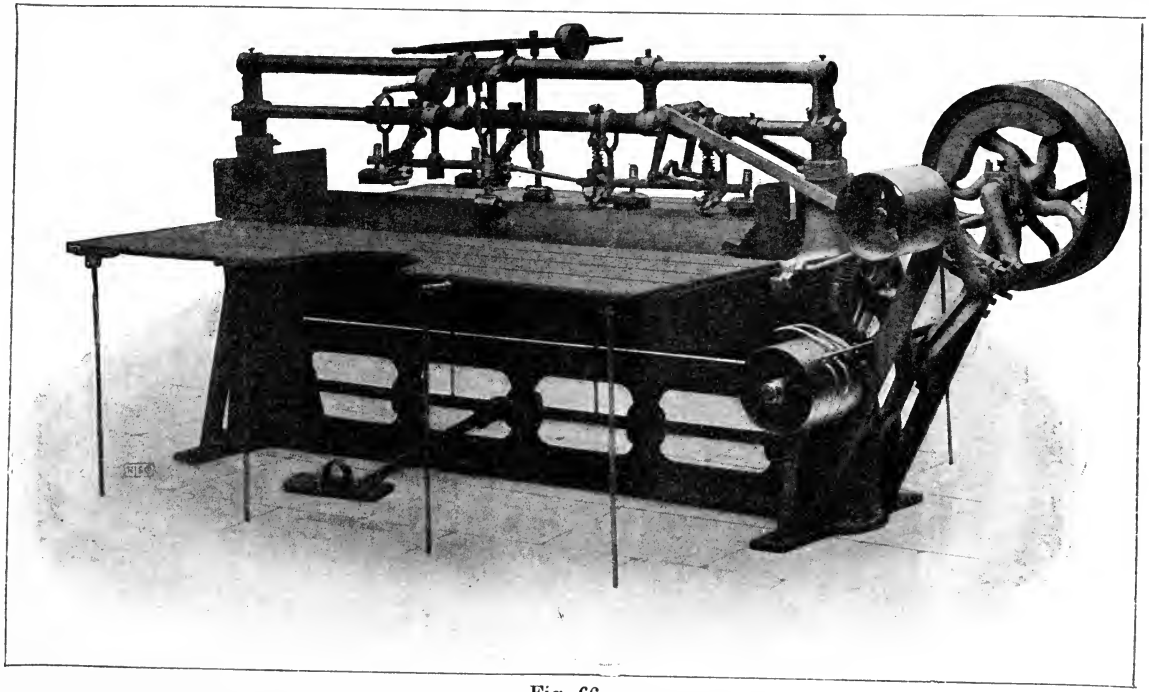

Fig. 66.

The old type of rolling machine consisted simply of a loaded box, to which was attached a brass roller. This was dragged over the butts, which were spread out upon a plank or zinc bed, and, although slow and cumbrous, the method is still regarded as the perfection of leather rolling. Fig. 22, p. 166, shows a form of spring butt roller by Huxham and Browns in which the necessary pressure is obtained from springs placed above the roller, which runs alternately backward and forward over a flat table beneath a fixed girder. The pendulum roller, Fig. 23, p. 167, is especially suited for sides, such as East India kips or Singapore leather, in which great firmness and a high gloss is necessary. The roller being narrow lends itself readily to the inequalities of substance, and its construction is very convenient to the manipulation of the irregular belly and shank portion of the side under treatment. Its oscillating motion causes much vibration and noise, so that it is best fixed wherever possible on the ground floor. It is, however, cheap, easy to make and repair, and well adapted to special classes of work such as are mentioned above.

A familiar and useful type of machine is the "C" roller, in which the leather is passed between two brass covered rollers. Practically any pressure may be obtained by a weighted lever attached to the top roller, but experience has shown that this type is unsuitable to butts, as it destroys the flat appearance, or—to use a technical expression—makes them "baggy." For bellies, shoulders, and splits this variety of machine is very suitable, as the cost of manipulation is not great by reason of the quantity of work done, whilst a simple reversible motion, obtained by using a crossed and open belt, obviates, to a large extent, any jumping of the rollers when narrow pieces of leather are under treatment. It may be added that nearly in all cases leather is rolled twice, the two operations being designated "rolling on" and "rolling off." After complete drying, sole leather is ready for the market, although in some cases colouring composition are applied to the grain side, and a final

brushing—which is now often done with a machine—given to bring up an attractive-looking gloss.

Leather Dressing Machinery.—The mechanical appliances employed under this heading are extremely numerous and ingenious, and, since the introduction of the chrome tannage, have been greatly augmented, although it must not be assumed that some of the machines mentioned here are not both used on chrome and other forms of leather making.

The term "dressing leather" is fairly comprehensive, and embraces harness, saddlery, mechanical, accoutrement, boot and bookbinding leathers, &c. Each of these branches of the leather industry is often a special business, but there are certain types of machines fairly common to all.

As most tanned leather is rough and uneven when it leaves the hands of the tanner for the currier, it is therefore necessary to equalize the substance in some measure. For harness and belting leather it is only usual to remove the loose flesh and the marked inequalities of the butt, but for such purposes as shoe leather, which depend upon a flesh side finish, this preliminary operation is very complete, and is technically known as shaving, an operation requiring a long training and a high pitch of perfection. Within recent years this process, which is done by laboriously paring the hide or skin with a suitable knife over an inclined "beam" or block of *lignum vitæ* (Fig. 58, p. 371), has been successfully attempted by machine (Fig. 67); in fact, by far the greater part of chrome tanned leather is now shaved in this way. Chrome leather, mainly on account of the looseness of its texture, is difficult to shave by hand, whilst the cost on goat skins makes it almost prohibitive. The principle of the shaving machine depends upon passing the damp leather under a rapidly revolving cylinder, to which is attached a series of steel knives, kept automatically sharpened by emery wheels. The leather is pushed up to the knives by a foot-lever actuating a rubber roller, and by a screw arrangement the distance

between the cutting and cushion cylinders may be regulated to suit the requirements of the operator. This piece of currier's plant is one of the most ingenious yet introduced, and is fast superseding hand labour on the lightest classes of goods. It is, however, yet capable of improvement, as it is rather dangerous to the operator, and somewhat deficient in reducing power on a close, firm texture, whilst the flying emery and steel dust is apt to stain ordinary vegetable tanned leather.

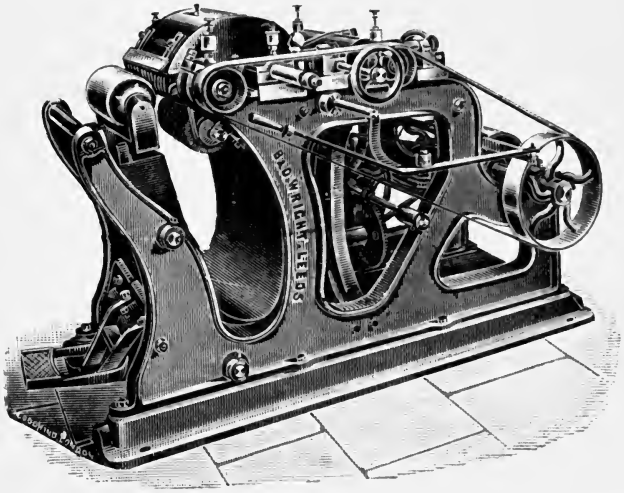

Fig. 67.

In practice both untanned and tanned hides are often divided into two or more portions by machine. The principle employed in splitting "green" hides and skins consists in passing the swollen and limey pelt over a wooden drum, whilst the division is made by the action of a rapidly vibrating knife. Attempts have been made to do green splitting by means of the band-knife machine (see Fig. 68), with a fair measure of success, and there seems no real reason why the difficulties should not be conquered with a little determined ingenuity.

Tanned leather is now almost universally split on the band-knife machine before mentioned. As the name implies, the cutting is done by means of an endless steel belt, which travels over two large pulleys, the edge being kept sharp by the automatic grinding of emery wheels below the machine. The machine is rather complicated and fairly expensive, but remarkably useful. The damp leather is fed between brass rollers to the knife's edge, the inequalities being provided for in the under roller by

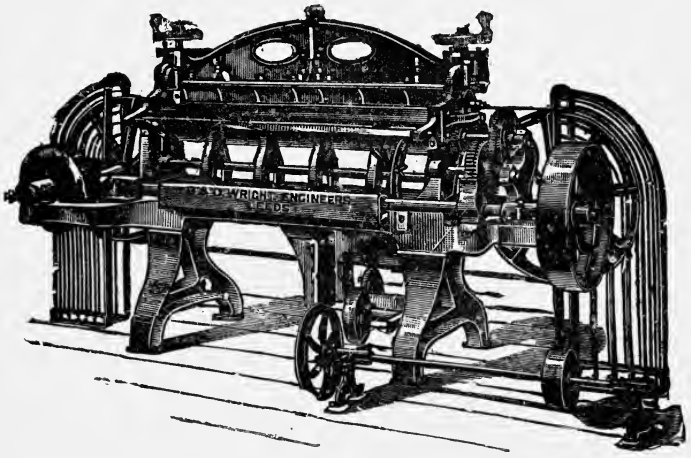

Fig. 68.

small eccentric brass sections, which in turn press upon a resilient rubber cylinder. This machine is capable of getting through an enormous quantity of work, but requires the services of a skilled and intelligent operator to secure good results. Butts for army upper and kindred purposes are split on an older form of machine known as the "Union" (Fig. 54, p. 322), the leather being pressed down and drawn over a fixed knife. For work of this class this machine has some advantages, as the split leather is more even in substance.

Scouring and Setting Machinery.—During the process of tanning by immersion in bark liquors, &c., the grain side of the leather, as already stated, becomes more or less filled with a whitish deposit called "bloom," known to chemists as ellagic acid. In most cases it is necessary to remove this, as it interferes with subsequent operations. The principle of the scouring machines is much the same as that followed out in sole-leather "pinning," where, indeed, the object aimed at is almost identical. As a matter of fact, it is usually only the heavier classes of upper belting and harness leather

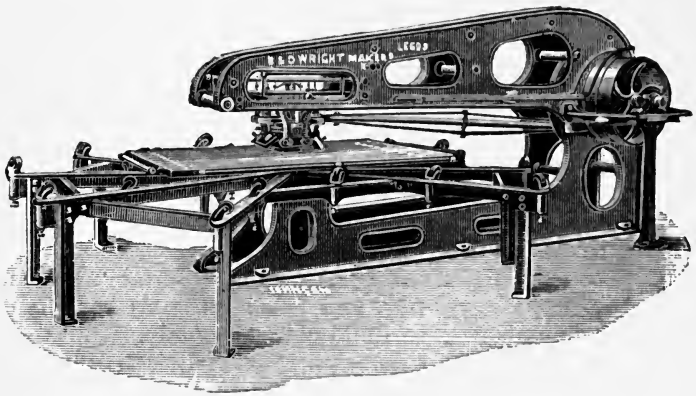

Fig. 69.

which are scoured by mechanical aid, and for this purpose a machine of the type illustrated in Fig. 69 is used to some extent in England. The leather is spread in a wet condition on a movable table, and is subjected to the action of a reciprocating head, which has a most ingenious motion. The amount of work these appliances get through is very great; but the first cost is heavy, and, in consequence, they have to be fairly fully employed to be profitable.

An older type of machine, known as the "Bourdon Scourer," is shown at Fig. 17, p. 156. In this case the

wet leather is passed under a cylinder into which are fixed projecting slabs of stone, which revolve at a high rate of speed, the leather of course being pressed up to the revolving working part by means of foot-levers actuating a suitable cushion. This machine is suitable for heavy leathers for military purposes, &c., but is little used for the finer classes of manufacture.

Leather is, after drum-stuffing, extended or "set" to eliminate the stretch and to give it pattern, and then dried. The same operation is necessary for chrome tanned leather after milling in fat-liquor, which is simply a weak emulsion of soap and oil modified to suit the particular method of leather manufacture. As the labour involved in setting is rather excessive, but purely mechanical, machinery has been introduced with great success in recent years. For belting leather the type shown at Fig. 69 is also used for this purpose, but there is no standard machine used by upper-leather manufacturers for setting, although many machines are capable of doing good work at a low cost where the shape of the leather is fairly regular.

Embossing and Softening Machines.—Certain leathers for shoe, upholstery, bag, and fancy purposes are often printed or embossed to imitate the natural marking of some other skin; thus sheep skin or basil is frequently stamped with a design to imitate morocco or alligator hide, whilst cow-hide, and even the flesh split, is embossed and finished to imitate the well-known marking of pigskin for legging purposes. Levant and memel leather for common and heavy boots are embossed with popular patterns, termed "star," "pebble," &c., and thousands of Bombay-tanned kips are stamped with a long barley-shaped grain and sold as cow-hide. All the smaller skins are embossed by passing them in a damp condition beneath an engraved roller. The more simple designs are cut by hand on iron or copper rolls, the more elaborate being electrotyped, whilst floral and artistic designs are impressed by submitting the leather to pressure under a prepared plate. The ordinary form

of embossing machine is shown at Fig. 81, p. 432. The embossing roller is now made in the shape of a hollow cylinder, and is thus easily removed from the working spindle. The most common size in use is the 4 ft. 6 in. machine, which takes the kip side or sheep skin quite easily. The smaller machines with 5-in. or 6-in. rollers are now seldom used, as the larger machine turns out the work faster and better.

Tanning and Stuffing Drums or Tumblers.—As drum-tumblers are used by the tanner and light leather manufacturer very freely, it will be perhaps necessary to say a few words on them here, although these machines have been to some extent dealt with in the chapter on Kip-Leather Currying. The form of tumbler illustrated in Fig. 70, p. 416, gives a fair idea of its construction and form; but it will be seen from the design which appears here that the drum is capable of many modifications. Some users prefer the door in the side as shown in Fig. 70, whilst others insist upon having the opening in the centre. The latter style has the advantage that the drum may be swung upon an axle, and this is a decided help when power and vibration are considerations. Some makes of tumblers are fitted with pegs standing up in the interior; others, again, possess shelves. A good deal depends upon the class of work required, or the individual fancy; but as the experience of expert engineers is always available, it is not necessary to take up valuable space by going very fully into these points. It is important, however, to note that a tanner's tumbler should be strongly built of the best seasoned timber, and that all exposed iron work is covered with some material which does not corrode by the action of the tannic acid; otherwise stained and spoilt leather is a certain result. These drums are also used for tanning proper, bateing, washing, &c., by the upper leather tanner, whilst the manufacturer of the lighter leathers finds them indispensable for re-tanning, sumacing, dyeing, stuffing, and a host of other purposes which will readily occur to the reader. In chrome tanning, too, the drum is

wanted in many ways, so that simple though this piece of tanning plant may be, yet it is important enough to warrant the attention of the leather trades' engineer, who has succeeded in improving it in many ways during the past few years. The improved form of stuffing-drum shown in Fig. 70 is fitted with an apparatus for introducing the melted greases and hot air.

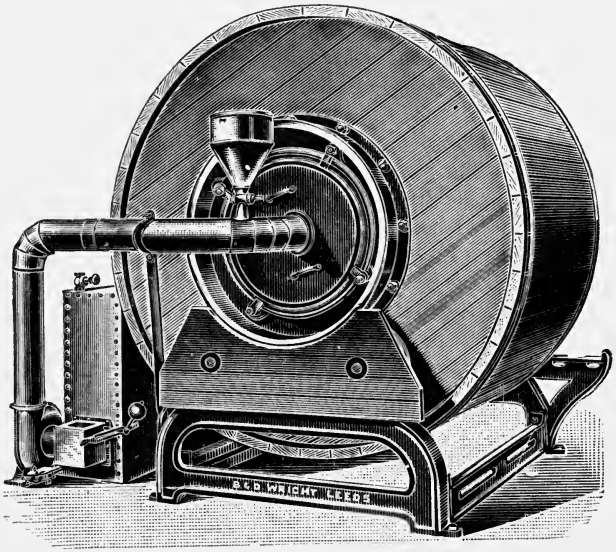

Fig. 70.

"Boarding" and Softening Machines.—Many forms of leather have to be softened by mechanical means, and various methods are employed to do this, according to the characteristics required. The old-fashioned tool, which is still used to a large extent, consisted of a suitably covered pommel, which was attached to the hand or arm under which the leather was rubbed. This has the dual effect of softening the leather and bringing up the

familiar pattern of the marking of the grain. The softening of levant shoe leathers is now done extensively by machinery, and for the rougher part of the work it has completely displaced the hand process. A common type of softening machine is shown at Fig. 71. In mineral tannages, such as alum and salt, or chrome, the softening or stretching of the fibre is an expensive business, and special machines, described in the section dealing with Chrome Leather Machinery, are freely used.

The final operation necessary to the finishing of most upper leathers which are dressed with grease, and which

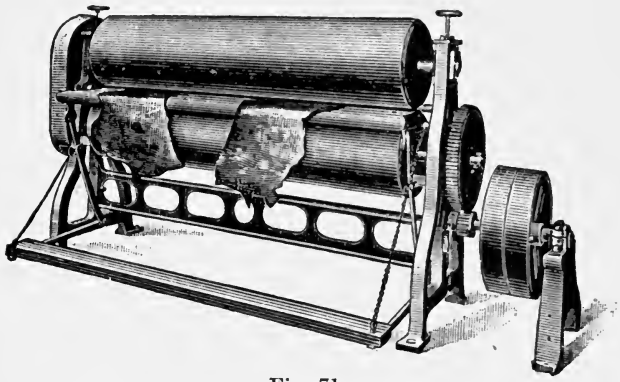

Fig. 71.

is termed whitening, is now often done by machine. The operation, including that of "buffing" the grain side, is done to some extent by an ingenious revolving cylinder of knives, which is given a sort of reciprocating motion. Attempts to use it have only been partially successful in England, mainly because the shoe manufacturer demands a very fine "face," or density of fibre, which is not easily obtained by machine, so that in some cases this final operation is carried out by cutting the surface of the leather by sharp turned edges of a tempered steel plate on an absolutely level surface. The

whitening machine in use in America, and to a limited extent in England, is shown in Fig. 72.

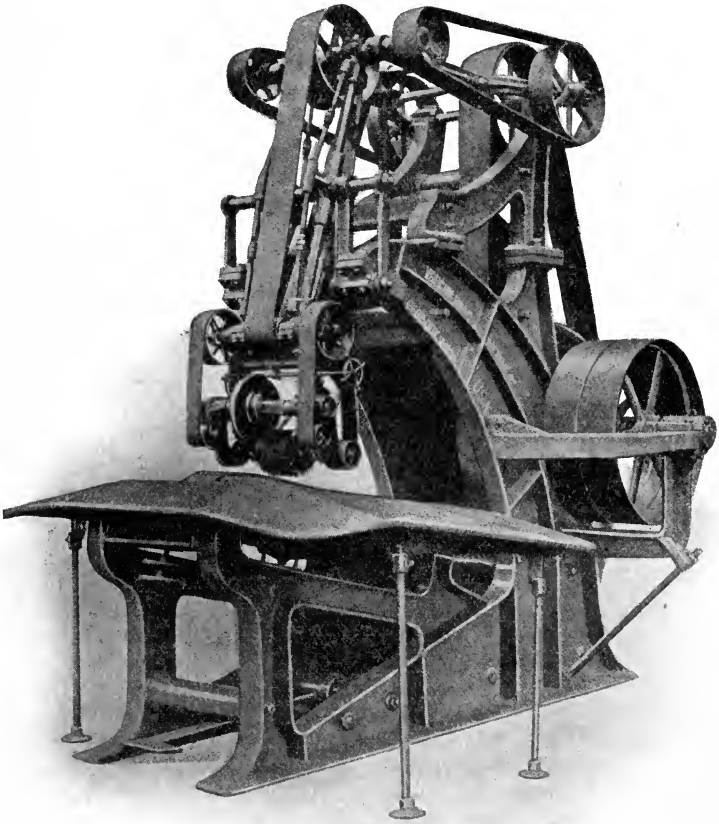

Fig. 72.

Minor operations in leather manufacture, such as blacking, glassing, brushing, fluffing, &c., are, of course,

often executed by machinery; but the design of these mechanical aids is simple, and their use so well understood that no space need be taken up with their description.

Machinery used in Chrome Leather Manufacture.

The rapid development of this branch of leather manufacture by America has given an impetus to the use of machinery that was little anticipated. The necessity for keeping the work going in an unbroken stream has doubtless had much to do with this, whilst declining profits and the high rate of wages paid for certain operations have all favoured the engineer. The enormous quantities of skins turned out by some of the great Philadelphia houses are almost beyond belief, as several calculate their output at from two to three thousand dozen glazed goat skins per day. It will be seen, therefore, that the difficulty of finding and controlling labour for such a trade is very great, and that the business has been built up largely by the co-operation of the engineer with the practical tanner.

Machinery used in the Beam House.—It is now possible to do almost every operation in what is known as the "wet work" by machine, and a brief summary of the machines usually employed may be useful as showing how independent the large American or European tanner is of skilled labour. Taking Patna dried goat skins as an example: these are usually well soaked in plenty of clean water, to which a little borax may be added with advantage, and are often mechanically softened by "stocking" or drumming for twenty minutes or so. In small yards the work is done by hand by "breaking" over the tanner's beam with a blunt knife.

The next step is to plump the skins and loosen the hair, which is done by immersing them in a solution of lime and arsenic sulphide. Unhairing is a cheap operation, but takes room, so that the use of machines has

been introduced with success, and as the same type of machine is used later on in the manufacture of chrome leather, the illustration at Fig. 73 may be studied with advantage. The skins are simply spread in a folded condition on each side of the vertical table, which by an ingenious motion passes between two revolving rollers,

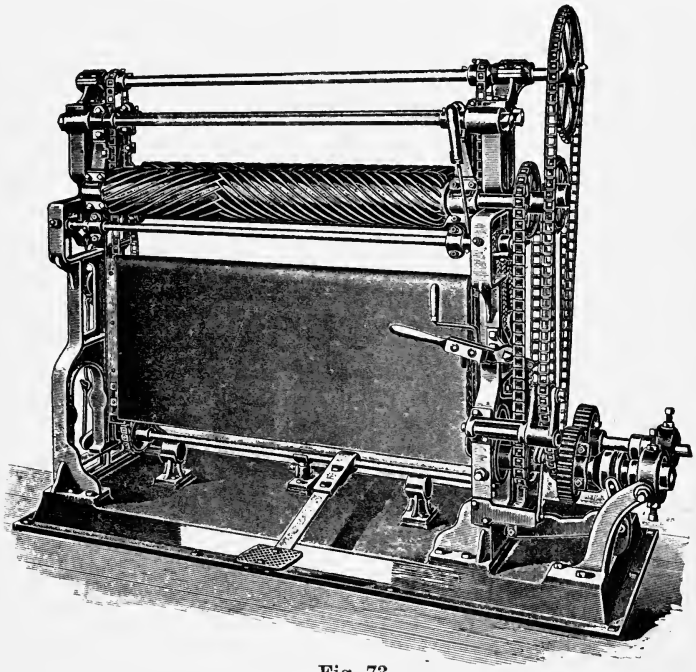

Fig. 73.

both of which are fitted with blunt knives, and revolve in different directions. The dehairing is not done very clean, but what remains is easily disposed of in a subsequent process. Other types of machines are also favoured for unhairing, and an enormous amount of work can be done on a modified form of the machine shown for sole leather at Fig. 64 (p. 403), whilst there are others equally

good upon the market—such as that shown at Fig. 74. The one drawback to the use of machines for this purpose is the rather large proportion of damage done to imperfect stock.

After unhairing the goat skins are usually fleshed. This process, being a skilled and expensive one, is now generally executed by a machine, the principle of which

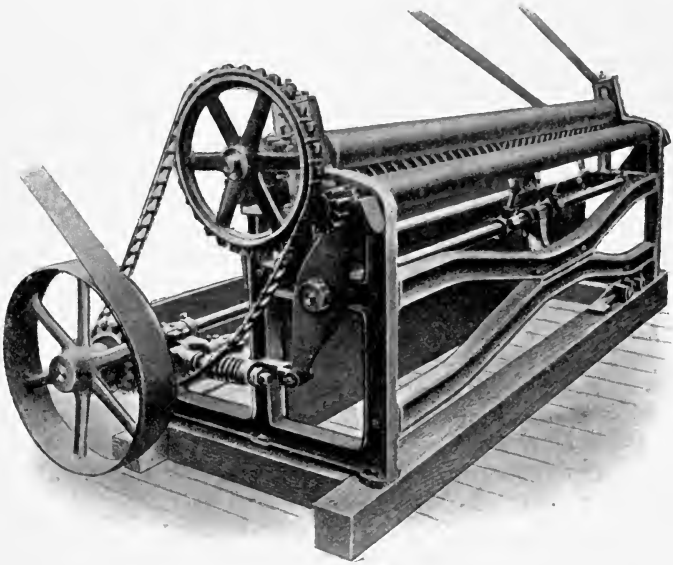

Fig. 74.

is much the same as that shown in Fig. 64 (p. 403) or Fig. 74, made by the Turner Co., Peabody, U.S.A. The limey and swollen skins are spread on a rubber-covered roller, and are passed under a cylinder fitted with knives, which are so arranged as to spread the skin outwards from the centre. It is as well to remember that very imperfect skins are best done by hand, as the rapid action of the machine makes it impossible to guard against further damage.

Passing on to deliming, or "puring," as it is technically called, it is useful to note that, even here, mechanical aid is necessary. Instead of the old-fashioned plan of immersing the skins in tubs containing the puring solutions, they are now almost always kept on the move by agitation in paddle tanks. The time of this very disagreeable operation is thereby considerably shortened, and the danger of damage to the goods reduced to a minimum. After the pure has "brought the skins down," *i.e.* reduced the plumpness caused by the lime, &c., a further working called "scudding" is necessary to expel the short hair, hair cells, pigment, and lime, soap, fat, &c., otherwise the resultant leather would be an inferior quality.

This operation is, in most progressive yards, now done by machine, the skin passing over a rubber-covered cylinder, whilst slate tools projecting from an upper cylinder more or less thoroughly cleanse the grain from impurities which, if not removed, would seriously interfere with the beautiful glazed appearance of the finished leather. As scudding is also done on much the same class of machine as that for fleshing—in fact, the same machine is often used with the insertion of a special roller—it is not necessary to illustrate this appliance. Goat skins for chrome leather are after scudding thoroughly washed in plenty of water and passed on to the actual tanning operation. As already explained, this consists of immersing the pelts in a solution of bichromate of potash and hydrochloric acid for a few hours, and then transferring them to a reducing bath of hyposulphite of soda and hydrochloric acid. This is followed up by a washing in borax or some other alkali to neutralise the acid present. The actual tanning is carried out in the paddle vat or tumbler—generally the former—already described, and the skins after the bichromate bath are struck out by a machine of the type shown in Fig. 73. The subsequent processes of "fat-liquoring" and dyeing are ordinary operations, and require no special comment in a section which only professes to touch on the technique

of the chrome process, as far as it is necessary to elucidate the working of mechanical appliances. The striking-out operation referred to above is repeated several times as required, the final "setting" or permanent extension being also given on the same machine. The operation is quite simple, the skin being folded down the back upon a vertical table which rises between two spiral knife-covered rotating cylinders. The effect is to thoroughly stretch the skin and to make the desirable fine grain. It is easy to use, one man and a boy being ample to attend to it, whilst the quantity of work got through is very great. Chrome leather shaving is now carried out on the machine shown in Fig. 67 (p. 411); results have proved that chrome leather is absolutely unfitted to hand labour, as the leather is exceedingly difficult to cut in any stage, and especially so in the "blue" condition, *i.e.* after the reducing bath. The lighter kinds of goat skins cost very little indeed to shave by machine, as they are fairly level, and only need reducing towards the head of the skin, whilst plenty require no more than a slight stroke to level them sufficiently to meet the market requirements.

Finishing Machinery for Chrome Work.—Most of the operations in the "dry work" are, in all the large manufactories, now executed by machine, as the cost is not to be compared with hand labour. The appliances used are mainly for softening and polishing, and as each skin has to undergo these operations several times, the cost even with machinery is fairly great. The dyed goat skin is, as we have already shown, after fat-liquoring, dyed, "struck," and set out, given a coat of glycerine and neatsfoot oil and dried at a high temperature. The leather at this stage is hard and "tinny," and requires plenty of mechanical work to bring it to a saleable condition. After cooling down and storing, the skins are usually damped back by placing them in damp sawdust for a few hours, and are then staked or softened by machinery. In the early days of chrome leather manufacture, this process was

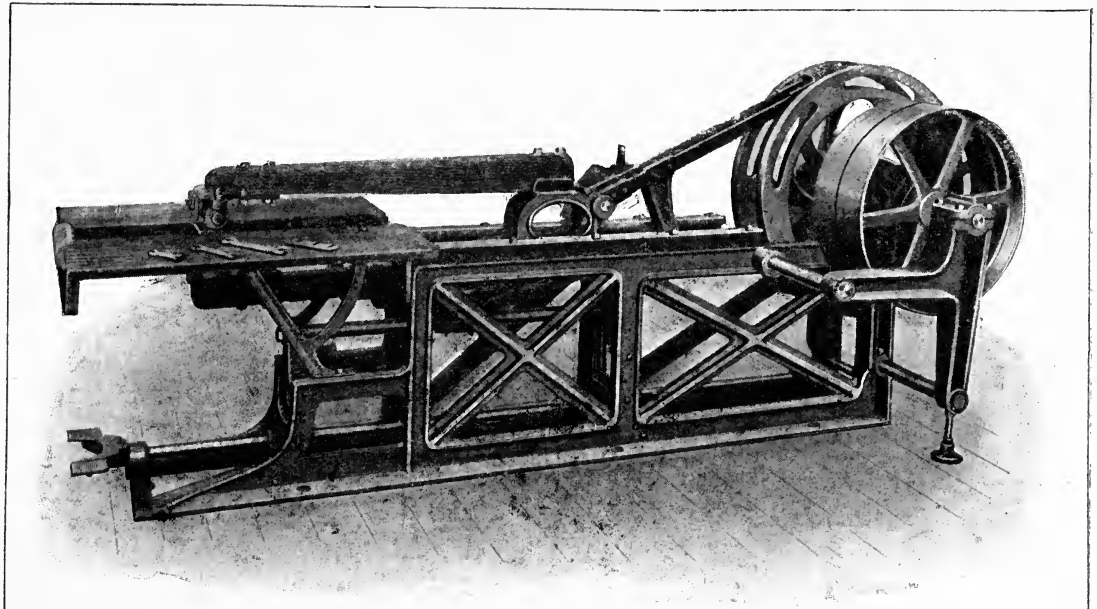

Fig. 75.

done by drawing the damp skin over a steel plate fixed into a wooden post, the knee being the main source of power, whilst the hands were used to guide and manipulate the skin. Another plan was to attach the skin to an upright "perch," and, by means of a short crutch, which had a steel plate at its extremity, the leather was extended in every direction. These crude methods are now gradually becoming obsolete, and the machine shown

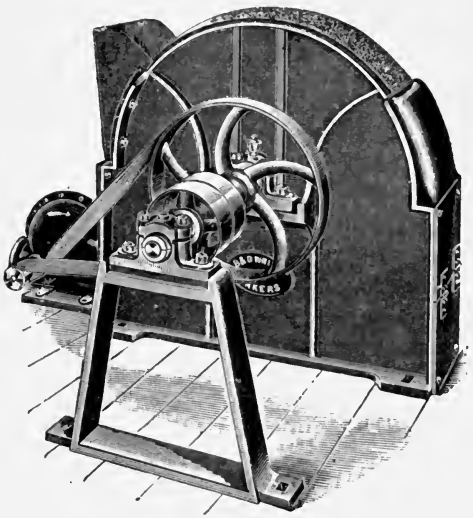

Fig. 76.

in Fig. 75 is one of the best tools for the purpose. The action is very simple, the leather being pulled between two steel plates; the opening and closing motions of the jaws of the machine are quite novelties in leather appliances, and are, in fact, somewhat startling to a beginner. As the operator has to take the entire "pull" of the machine by the pressure of his body to the leather, it is well to put a fairly strong man to work it, otherwise accidents might occur, or, at least, imperfect skins get

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hopelessly damaged. There are, of course, other staking machines on the market, but the principle is much the same. The skins are staked twice, or even three times, according to requirements, and are usually glazed after each staking. The foundation for the glaze, consisting of a weak solution of blood albumen, is usually applied with a soft pad to the grain side of the skin, and partially or wholly dried before passing on to the machine. The

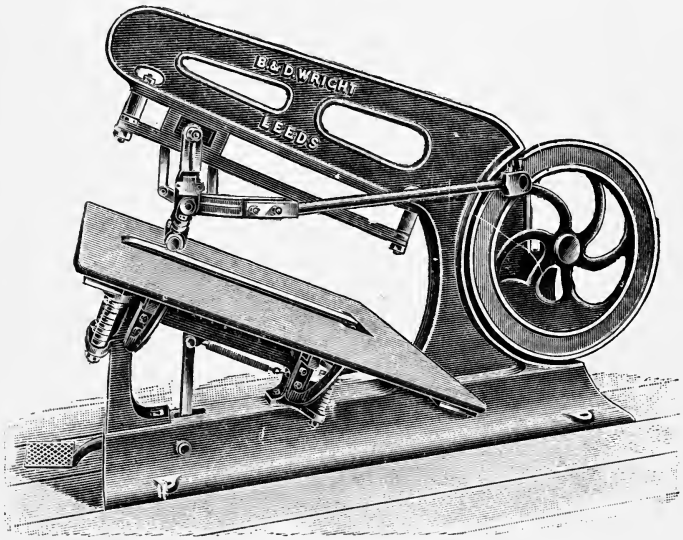

Fig. 77.

flesh side, too, is often "fluffed," *i.e.* abraded on a wheel, much on the principle of the grindstone, with the difference that fairly coarse emery powder is the abrasive medium. The wheel is of iron, and is shod with a stout wooden tyre slightly rounded off, this forming the bed for the emery. The dust from the operation is very troublesome, but is removed to a large extent by well-arranged fans, which draw it away from the operator to

a suitably placed receptacle. A familiar type of this machine is shown at Fig. 76.

The final operation of glazing is certainly one of the most important in the manufacture of chrome kid, and involves a great amount of technical skill. The staking

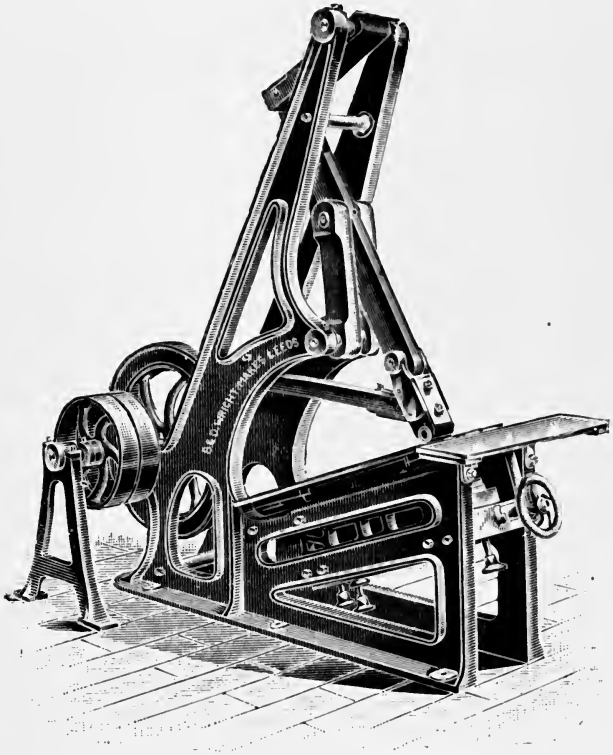

Fig. 78.

has had the effect of disturbing the "lay" or pattern of the skin, and unless the manipulation is almost perfect, the damage done by the rapid action of the polishing tool is apt to be very great. Types of machines used are

shown at Figs. 77 and 78. These are more generally used for glazing vegetable tanned leather, whilst Fig. 79 has some special points of excellence, which make it specially suitable for polishing light chrome stock. For goat, however, a spring head is used. The frames may be either of wood or iron, but the former is claimed to give a greater resiliency, which has a beneficial effect on light

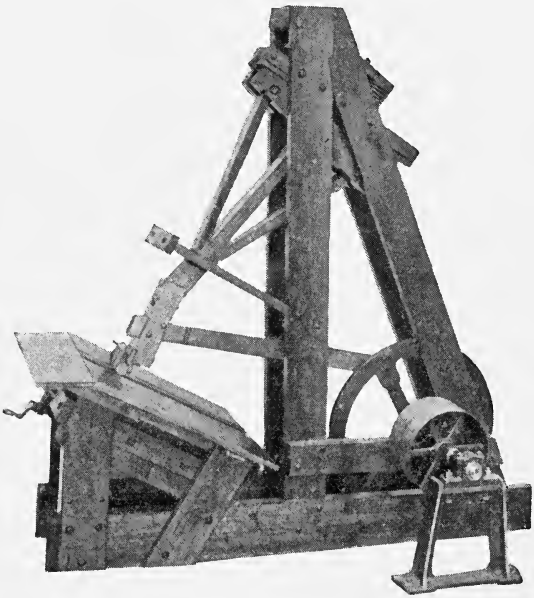

Fig. 79.

and thin stock. Reference to the illustrations will show that the working arm carries a small cylinder of glass or agate, which strikes the extended skin with a rapid downward motion. The rate of speed varies, according to the work and the fancy of the operator, from 80 to 120 strokes per minute. The oscillating motion caused by this class of machine is great, and

it should be very firmly fixed, both from above and below, if good results are to be obtained, otherwise the damage from broken skins and glazing glasses is apt to prove rather an expensive item. Probably users of this machine would, under any circumstances, do well to remember that it is a costly business to

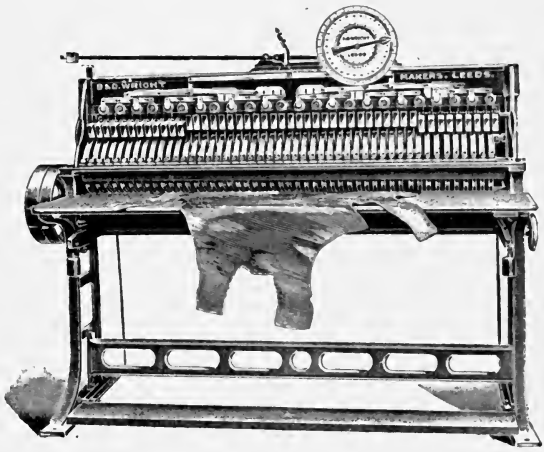

Fig. 80.

train operatives for this process, so that only the most intelligent men should be selected.

Before concluding this article on the mechanical appliances used in chrome leather manufacture, it may be mentioned that a measuring machine has now become an indispensable adjunct to a works of any size (Fig. 80); this is in America and Europe the recognised standard for leather-measuring between buyer and seller. The skin, in travelling through the machine, affects the measuring segments arranged close together, which in turn are registered on an index, carefully noted by the operator, and marked on the skin. This machine is very ingenious, and soon pays for the cost of the outlay as every inch of the leather is calculated; and as all

chrome leathers are sold by surface measurement, it will be seen that it is an absolute necessity that this end of the business should be well looked after.

The most recent idea for measuring the superficial area of leather is, however, Connolly's Areameter. The instrument is simplicity itself, and broadly consists of a set of geared wheels, to which are attached a convenient arm carrying a pointer. This latter is passed around the edge of the skin to be measured, and the result read off on a dial attached to the central part of the machine. After exhaustive tests, made by Dr. Glazebrook of the National and Physical Laboratory, the Areameter has been recognised as an official standard by the Board of Trade; and at a recent meeting of the Leather Trade Section of the London Chamber of Commerce it was recommended to the trade "for verifying the measurement of leather and skins, and as a means of determining disputes between buyer and seller." The machine is put on the market by Connolly's Areameter Company, Brighton Chambers, Denman Street, London Bridge, London, S.E., and is made in various sizes to suit the convenience of users.

In bringing this article to a close, it may be said that no attempt has been made to go fully into the technical details of leather manufacture; the idea has been simply to give just a few practical hints to readers who may not be familiar with the class of machines mentioned. Further particulars relating to the chrome process have already been given in another chapter.

CHAPTER XXXII.

EMBOSSING LEATHER.

Copying Crocodile, Alligator, &c., Skins.

THE art of embossing and otherwise ornamenting leather dates back from a very early period, the Egyptians having practised the art nearly three thousand years ago. At a much later date, namely, about the thirteenth century, the art appears to have been extensively practised not only in Italy and Spain, but also in England, many specimens of which are still extant.

The more modern applications of embossed leather have been chiefly devoted to leather employed in bookbinding, furniture, bags and reticules, purses, and other fancy articles; while still more recently—with the aid of the electrotype process—moulds of reptile skins, as those of the crocodile, alligator, &c., have been taken, by means of which excellent imitations of the natural skins have been produced, possessing all the beauty of the original skins at a lower cost to the purchaser.

Embossing machines are made by the following firms of engineers: Messrs. Joseph Hall & Co., T. Haley & Co., B. and D. Wright, Leeds, and Messrs. Farrar & Young, Bramley. The Moenus Machine Co., Frankfort-on-Main, also make embossing machines, their latest design, "The Altura," being one of the most successful pieces of plant ever put on the market for leather work. Messrs. Huxham & Brown, of Exeter, have also lately introduced a special kind of machine for the purpose, and the writer has seen excellent work done by it in a very rapid and effective manner.

Copying Crocodile, Alligator, &c., Skins by Electrotype.—It will be readily understood that by the electrotype process perfect impressions of the skins of the crocodile, alligator, boa-constrictor, and other reptile skins can be obtained, and from the copper moulds thus

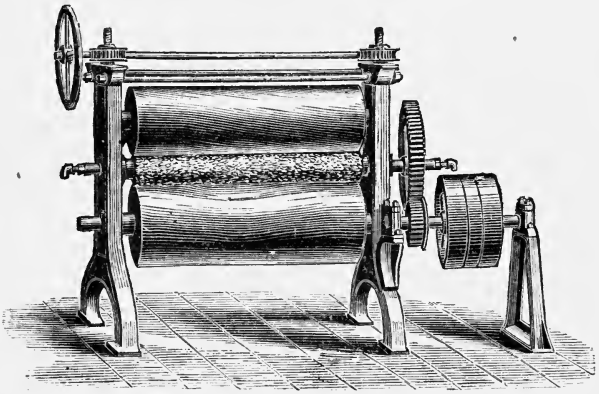

Fig. 81.

produced, leather, previously damped with water, can be impressed, and exact copies of the original obtained to an unlimited extent. By the same process morocco, seal, and other skins are reproduced, and form an extensive and greatly increasing branch of leather manufacture, some of

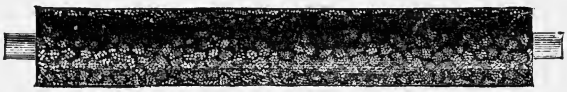

Fig. 82.

the results obtained being exceedingly beautiful, the finest markings of the grain being reproduced with perfect fidelity. Electrotyped copper rollers and plates, bearing the pattern of real skins, can now be obtained for the manufacture of almost any variety of imitation leather, and from each roller several thousand copies may be

produced. In Fig. 81 is shown the ordinary form of embossing and printing machine made by the above-named firms, and in Fig. 82 is represented an electrotyped copper roller. Small hand-presses are made by the same

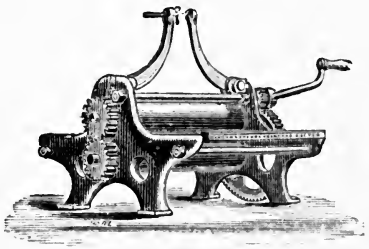

Fig. 83.

firms for printing from electrotype plates of real skins up to 22 inches by 27 inches, the embossing machine being employed for larger surfaces. An illustration of one of these hand machines is shown in Fig. 83.

CHAPTER XXXIII.

FELLMONGERING.

Classification of Sheep Skins.—Treatment of the Skins.

ALTHOUGH *fellmongering*, or removing the wool from sheep and lamb skins, is a distinct and separate trade, more especially in London, the art is sometimes combined with the other operations of the light leather manufacturer in some parts of the country, and therefore a brief description of the method of treating sheep skins by the fellmonger will, it is hoped, be useful. Indeed, even if not practised by the skinner or manufacturer of light leather, he should at all events be conversant with the method adopted to free the skins from wool before they come into his hands, since this will enable him to judge from the appearance of the pelts whether the process has been properly conducted or clumsily and carelessly performed; and it is well known that fellmongered skins have frequently exhibited unmistakable signs of careless and injudicious treatment. Sometimes the skins have been piled in heaps to make them *sweat*, producing incipient putrefaction, by which the workman's labour in removing the wool was rendered easier; but the effect of this is that much of the substance of the skin is rendered soluble, even in cold water, and consequently the skins suffer loss in weight when passed through weak lime liquors.

The London fellmongers, who conduct their business upon a very extensive scale, and with every possible care, have a high reputation for the excellence of their sheep pelts; the same may be said of many of the provincial

fellmongers, who know the importance of having their workmen well supervised when conducting operations requiring skill and judgment.

Classification of Sheep Skins.—The skins of sheep slaughtered in Great Britain are divided into *large*, *medium*, and *small* skins, and may be arranged under the following heads: 1, Lincoln, Leicester, Cotswolds, and other large kinds weighing from 9 st. and upwards; 2, Southdowns, Scotch, and other skins of medium weight; and 3, Skins of small Welsh mountain sheep, foreign sheep slaughtered in this country, and the numerous varieties of lamb skins.

The larger stout sheep skins are usually *split* by machinery, the *grain side* being used for *skiver*, and the *flesh side* employed in preparing buff or "shamoy" leather (oiled leather), and in the manufacture of parchment. A considerable number of the larger heavy sheep skins are tanned into what are called *basils*, the West of England being specially famous for its oak-tanned basils, while Scotland and some of our northern counties also produce vast quantities of basils, which are tanned with larch bark, and are much used by saddlers for lining the heavier leathers. It is believed that the aromatic odour imparted by larch bark gives to the leather prepared with it similar attributes to those generally accorded to Russian leather. Considerable numbers of the larger sheep skins are *tawed* with alum and salt.

The medium weight skins are chiefly tanned with sumach for *roans*, a variety of leather somewhat resembling morocco, but wanting its peculiar grain. These skins are also used for preparing leather used for the rollers of cotton spinning machinery. The small sheep skins of Wales and Scotland and the mountainous districts of England are employed in the art of *tawing*, for gloves, shoe linings, and numerous other purposes. Cape sheep and lamb skins are very extensively used by the manufacturer of light leather, being nearly equal to goat skins, and the leather prepared from them is largely used for making *dog-skin* gloves, and many kinds of coloured gloves exposed for sale as *kid gloves*.

Treatment of the Skins.—The skins are first thoroughly

washed in water, to cleanse them from filth and dirt, after which they are spread out flat, one above another, with the flesh side upward. Each skin is then painted over with a thick cream of lime on the flesh side. The skin is next doubled, with its wool side outward. The skins are then piled in heaps of about twenty skins, and allowed to remain undisturbed from twenty-four to forty-eight hours, at the end of which time the wool has become loosened, and the workmen, unfolding the skins one by one, proceed to pull the wool off, keeping the various qualities separate. When the wool is removed, the pelts are thrown first into water, and afterwards into a pit containing a weak lime liquor, from which they are drawn once or twice a day, the liquor being stirred or *plunged* each time before replacing them in the pit, so as to equalise the action of the lime. They are treated in this way for the first three or four days, after which they are subjected to a stronger lime liquor, being repeatedly drawn daily as before, and by the end of from seven to ten days, according to the season, the skins are ready for unhairing—that is, removing the hair from the shanks and other parts left after the first operation. In the early part of summer, while the wool is very short, the skins, after being shorn of the wool, are treated somewhat differently. They are first thrown into water to remove the filth, after which they are placed in lime liquor, being lifted once or twice a day as before, and then subjected to stronger lime liquors, in which they remain until the wool readily yields to the touch, when it is removed in the usual way. By this treatment the value of the wool is impaired, but this in the case of shorn sheep is of little consequence. The wool is disposed of to the *woolstaplers*, who cleanse and prepare it for the woollen manufacturers.

CHAPTER XXXIV.

PARCHMENT, VELLUM, AND SHAGREEN.

Preparation of Parchment and Vellum.—Skins for Drumheads.—Shagreen.—Fish Skin, or Fish Shagreen.

Preparation of Parchment and Vellum.—The employment of this substance for writing purposes is of very early date, and is said to have been invented by Eumenes, King of Pergamos, in Asiatic Turkey, about two hundred years before the birth of our Lord. In ancient times it was known as *pergamena*, and was used, on account of its durability, for writings of great importance, and as a substitute for the *papyrus*, or writing paper of the ancient Egyptians. There are two principal varieties of this substance, which are known in commerce under the names of *parchment* and *vellum*, the latter being prepared from the skins of calves, kids, and still-born calves and lambs, and the former from sheep and goats. In the preparation of parchment and vellum, the manipulation of the skin is much the same, but in the latter case somewhat greater care is necessary owing to the very delicate nature of the skins to be treated.

The skins are washed, limed, unhaired, and fleshed, again well washed, and then stretched either on hoops or, in large manufactories, upon a wooden frame called the *herse*. This is formed of two uprights and two cross-bars, well joined together by mortising, so as to form a strong frame to be fixed to a wall. The four bars are perforated all over with a number of holes, to receive tapering boxwood pegs, in each of which is a hole, as in the pegs of a violin, to receive the strings which are

employed in stretching the skin. A wooden shelf is fixed above the *herse* to support the tools used by the workman. To stretch the skin, skewers of various sizes are used, according to the size of the piece of skin to be secured. Six holes are made in a straight line to receive the larger, and four to admit the smaller pegs or skewers. These small slits are made with a tool like a carpenter's chisel, and the exact size to admit the skewer; the string round the skewer is fixed to one of the bolts of the frame, which are turned round by means of a key resembling a pianoforte tuning key. The skewer is threaded through the skin while taut. Being thus prepared and the skin well softened with water, the workman stretches it powerfully by means of the skewers; he attaches the strings to the skewers, and fixes their ends to the pegs, which he then turns with the key, taking care not to allow any wrinkles to be formed. It is usual to stretch the skin more in its length than in its breadth. He then takes a fleshing tool, which is a double-edged knife made fast in a double wooden handle, in both hands, and scrapes or shaves the skin from above downwards, by which he removes the fleshy matters, which are afterwards collected for glue-making. The herse is then turned round from the wall, and the grain side of the skin is then scraped with the tool in an inverted position, so as not to cut the grain of the skin.

The herse is again turned, and the flesh side of the skin is next dusted over with sifted chalk or slaked lime, and is then rubbed over in all directions with a large piece of pumice-stone, previously rubbed flat upon a sandstone; the moisture in the skin is quickly absorbed by the chalk. When sufficiently rubbed on the flesh side, the skin is again turned, and the grain side rubbed in the same way, but without the use of lime or chalk. The above operation is generally applied only to the better qualities of parchment or vellum. The skin is then allowed to dry upon the frame in the shade, care being taken to avoid sunshine and also frost. In very hot and dry weather the skin is damped with a wet cloth, to prevent

it from drying too quickly; the skewers are tightened after each damping.

When quite dry, the chalk powder is removed by rubbing the skin with the wool side of a piece of lamb skin. It is of great importance in pumicing not to injure the texture of the skin. If the skins are greasy they must be immersed in the lime-pit for a week or ten days, then stretched again upon the herse, and afterwards handed to the *scraper*, who here employs an edge tool of the same shape as the fleshing knife, but larger and sharper. He mounts the skin upon a frame like the herse, but extends it merely with cords, without skewers or pegs, and supports it generally upon a piece of raw calf skin strongly stretched. The tail of the skin being placed towards the bottom of the frame, the workman pares off with a sharp knife any considerable irregularities, and then scrapes the outside surface obliquely downwards with the proper tools till it becomes perfectly smooth. Any remaining irregularities are removed with the pumice-stone. This operation is performed by laying the rough parchment upon an oblong plank of wood in the form of a stool, the plank being covered with a piece of soft parchment stuffed with wool, forming a cushion, for the grinding operation. It is the grain surface only that requires pumicing. The famous Strasburg vellum is prepared with very fine pumice-stones.

Skins for Drumheads.*—The skins for drumheads are prepared from the skins of calves, and for kettledrums from asses' skins. These are treated in the same way as above. Parchment is usually coloured only *green* by the following process: In five hundred parts of rain water boil eight parts of cream of tartar and thirty parts of crystallised verdigris; when this solution is cold, pour into it four parts of nitric acid. Moisten the parchment with a brush, and then apply the above liquid evenly over the surface. Lastly, the necessary lustre may be given with albumen (white of eggs), or mucilage of gum arabic. (*Ure.*)

* The skins for banjos and tambourines are generally prepared from the skins of still-born calves.

The sieves used in powder-mills for granulating the gunpowder are made from parchment prepared from hog skins. English vellum is frequently made from split sheep skins.

Shagreen.—This name is given to a peculiar kind of parchment, and is prepared from the skins of the horse, wild ass, and camel, as follows: The skin is freed from its hair and cuticle by being long soaked in water, and after dressing with the currier's fleshing knife is sprinkled over, whilst still wet and stretched, with the seeds of a species of *Chenopodium*, which are imbedded in it by strong pressure, and in this state it is dried. The seeds are then shaken off, and the surface is rubbed or shaved down nearly to the bottom of the seed-pits or indentations; it is next soaked in water, by which the skin swells, and the recently depressed surfaces rise into a number of minute prominences; it is then tawed with alum, and is lastly dyed and smoothed off, or saturated with mutton tallow. *Black* is given to the skin by means of galls and copperas, *blue* with a solution of indigo, *green* with copper filings and sal ammoniac, and *red* with cochineal and alum. Shagreen was formerly extensively used for covering the cases of watches, spectacles, and surgical instruments.

Fish Skin, or Fish Shagreen.—This is prepared from the skins of certain species of shark, which are covered with horny projections in lieu of scales. The skins are stretched upon frames and dried, in which condition they are sent to market. When deprived of the projecting spines they are dyed and used for covering small boxes, tubes of small telescopes, &c.

CHAPTER XXXV.

GUT-DRESSING.

Preparation of Cattle Intestines: Continental Method.—Goldbeaters' Skin.—Lathe Cords.—Cords from Sheep Intestines.—Cords for Tennis Bats, &c.—Whipcords.—Gut Strings for Musical Instruments.

The art of gut-dressing consists in separating the muscular coat of the intestines of certain animals from its external or peritoneal covering, and from its internal lining, or mucous membrane, and is divided into two distinct branches: 1, the preparation of the intestines of oxen and cows to be used in the preparation of alimentary substances, as sausages, polonies, &c.; and 2, the preparation of the intestines of sheep for the manufacture of cords or strings for musical instruments and various other purposes.

Preparation of Cattle Intestines: Continental Method. — Dussauce describes the workshop of the gut-dresser as "a room about 20 feet long, 16 feet wide, and 12 feet high, with four windows. Around the sides of the room are ranged casks holding about sixty gallons each, and in the middle of the floor are fixed wooden stakes for attaching hooks. A well is usually sunk in the yard to receive the waste matters of the factory."

There are eleven distinct operations in gut-dressing, the first of which is—

Scouring.—As the small intestines of oxen and cows are received from the slaughter-house they are steeped in water to moisten and smooth them, so that the knife may slide easily over their surfaces. One end of the intestine is now tied into a kind of knot round a hook to one of the

stakes in the centre of the room, the hook being about six or seven feet above the floor. The workman then grips the depending portion between the forefinger and thumb of his left hand, and gradually slides the hand down along the whole length of the intestine, and follows its motion by passing a knife, held in the right hand, over the surface, to separate the fat as far as possible from the outer coat. Another portion of gut is treated in the same way, and so on until the entire caskful has been cleaned. Any portions which have been accidentally cut by the slaughterman are laid aside. The fatty matter scraped from the gut is well washed and melted, or *rendered*, as it is termed, and disposed of to the soapmaker.

Turning Over.—The intestines are next washed in a large cask half filled with water, and the workman next proceeds to turn them inside out by introducing a thumb into the interior of each, and working the gut upon it with the fingers until the whole length is inverted. A number of the pieces are then tied together at their ends with a cord attached to the edge of the cask, and when a sufficient number of inverted intestines are thus secured they are ready for the next operation.

Putrid Fermentation.—The object of this process is to decompose the mucous lining and other parts which have to be separated from the middle coat of the intestine, and if the operation is not conducted with great care the whole substance of the gut will become softened and rendered useless. The putrefaction is allowed to proceed for two or three days in summer and from three to eight days in winter, and it is known to have progressed far enough when bubbles of gas are seen to arise from the surface of the intestines.

Scraping.—The pieces are first untied, then soaked in a tub half full of water. The workman next proceeds to remove the decomposed mucous membrane (which is now outward), by scraping it off with his thumb nails until it is completely removed, and he facilitates the process by occasionally dipping the pieces in water.

Washing.—The intestines are put into a tub nearly full

of clean water, being stirred about several times every day, the water being changed two or three times a day, and the operation continued until the water comes from them perfectly clear and free from smell.

Inflation.—When thoroughly cleansed by the foregoing operations, one end of each piece is tightly tied by a piece of string. The workman next introduces into the open end a hollow cylinder of cane or reed about 5 inches long, and after making this air-tight by pressing the gut tightly round it, he applies his mouth to the cane tube and inflates the gut by blowing into it. He then ties the end below the tube, and the piece is ready for drying.

Drying.—As soon as all the pieces are filled with air they are conveyed to the drying place, where they are laid out separately upon horizontal poles placed about 5 feet from the ground, and here they are left until dry. When thoroughly dry they are taken down, cut across with scissors as near the ligatures as possible. They are next pressed and flattened with the hand to expel the air.

Measuring.—The dried pieces are next sorted into different sizes, according to the purpose for which they are to be used; they are then collected into bundles, and hung in a damp place previous to being submitted to the next process.

Sulphuration.—When sufficiently damp, the pieces are next exposed to the fumes of sulphur, in a chamber about 5 feet square and 6 feet high. They are first strung on sticks, and if not sufficiently moist they are sprinkled over with water from a brush; they are then suspended across the upper part of the chamber to the number of about 100 bundles. About one pound of flowers of sulphur is then put into an earthen dish placed on the floor of the room, and upon this red-hot cinders are laid; the door is then quickly closed, to retain the sulphur fumes within the apartment, and every aperture is secured by luting or by glueing pieces of paper over them. After a few hours the door is opened and the fumes allowed to escape, when the pieces are found to be bleached and deprived of all objec-

tionable odour. While still damp, they are twisted into hanks, packed with camphor, and are then ready for market.

Goldbeaters' Skin.—This is prepared from the external or peritoneal coat of the *cœcum* or blind gut of neat cattle. The workman separates and turns over the part which encircles the junction of the pouch with the rest of the intestines, and draws it off, inverted, from the other coats to the length of 25 or 30 inches. It is then soaked for a short time in a weak potash liquor, and is next cleaned by scraping with a knife upon a board; it is then soaked in water, and afterwards stretched upon a kind of frame from 40 to 50 inches long and 11 inches wide. This frame consists of two uprights held together by two cross-bars, having longitudinal grooves $2\frac{1}{2}$ lines in width. The outer surface of the membrane is placed in contact with the upper part of the frame, and it is stretched in every direction, after which it is glued to its rim. Another membrane is then stretched over the first, with its outer surface upward, and secured by glueing round its edges. When dry, the membranes are separated by passing a knife along the grooves. Each strip is then glued upon a similar frame, but without grooves, and is washed over with a weak solution of alum, made by dissolving one ounce of alum in two quarts of water. When dry, the surface is wiped over with a sponge dipped in a strong solution of fish-glue in white wine, flavoured with clove, nutmeg, or camphor. When this is dry a coating of white of eggs is applied, and after again drying each strip is cut up into pieces $5\frac{1}{2}$ inches square, which are then smoothed under a press and afterwards made up into leaves.

Lathe Cords.*—These are prepared from the intestines of horses, cleansed and prepared as before described, and the pieces are cut into bands or strips of equal width in the following way: A wooden ball, furnished in its lower part with four equidistant cutting blades, is fixed by a

* Gutta-percha and vulcanized india-rubber have greatly superseded gut cords for lathes.

wooden upright to a bench. The end of an intestine is then drawn over this ball, and as the gut is pulled downward it becomes divided into four equal strips. From four to eight of these strips, according to the thickness of cord required, are tied with a peculiar knot to one end of a stout piece of cord; the end is passed round a peg inserted into a hole in a solid post, to the side of which a number of pegs are attached. About ten yards from this post is another post, also provided with pegs; over one of these latter the middle strip of the cluster is bound, the other end being brought back and attached to the first peg by another knotted cord. The tied ends of the strips are then attached to the wheel by a hook connected with a *whirl*, which is made to revolve until the strips are sufficiently twisted. The twisted end is then kept stretched by attaching it to the peg, and any projecting filaments are cut off. After stretching some time, the cords are twisted again, and the third and fourth time this is done by hand, being rubbed with and drawn through a bunch of moistened horsehair each time after twisting, and again stretched out between the two posts. If the cord is not smooth and even when the twisting is completed, it is rubbed with a piece of dog skin. The cord is then dried, but some manufacturers expose it to the fumes of sulphur. The ends are now cut off and the cord is rolled into a coil.

Cords from Sheep Intestines.*—It is important that the intestines should be *fresh*—that is, free from decomposition. They are first cleansed from fœcal matter and washed; they are then taken to the workshop, where they are soaked in a tub of water and deprived of adhering fat. The smaller ends are then tied together and laid on the edge of the tub, while the remainder are allowed to steep in the water for several days, the water being frequently changed. The peritoneal and mucous coats are then removed by placing the intestines on a bench, which slopes towards the rim of the tub, and the surface is scraped with the back of a knife-blade to separate the membranes to the width of about half the circumference. This is done

* Erroneously called *catgut.*

by pulling it off in pieces from the smaller end of the intestine towards the larger end. The gut is next soaked in water for twenty-four hours, and afterwards scraped clean upon the bench with the rounded back of a knife. About 8 feet of the larger ends are now cut off for use by the sausage-makers; the remainder are cut into lengths and stratified with salt, which is termed *curing*. After remaining in the salt for some days they are soaked in water for a night, and next day they are immersed in a ley composed of pearlash 8 oz. dissolved in water 4 gallons. The ley is poured over the intestines, and every two or three hours the liquor is poured off and the intestines are examined to ascertain if they have been sufficiently acted upon by the alkali. They are next drawn several times through a brass thimble open at both ends, and then sorted, according to their sizes, for the different purposes to which they are to be applied.

Cords for Tennis Bats, &c.—These are generally made from intestines of inferior quality, or such as have been stained by incipient putrefaction. The pieces while still moist are sewn together with strips of the outer membrane, or *filandre*, each junction being cut obliquely, so as to make it level and strong. Three or four of these intestines are thus attached by strings to the whirl, and are twisted as usual, after which the cord is smoothed and deprived of moisture by the workman's hand; it is then stretched for a time, when it is again twisted and rubbed with the bunch of horsehair. The inferior kinds of cords are prepared by twisting one gut along with two or three lengths of the outer membrane.

Whipcords.—These are made from intestines of good quality, prepared as before, each end being twisted separately, since these cords are seldom made from two intestines sewn together. The cord is "sulphured" once or twice, and is then smoothed and dried, after which it is coiled in certain lengths for sale.

Gut Strings for Musical Instruments.—Of all the purposes to which the intestines of animals are applied, none is so important as their conversion into what is

commonly called *catgut*, for the strings or cords of "stringed" instruments, including the whole violin family and the harp. From the earliest period Italy has been most famed for the production of violin strings of the finest quality, a reputation which she has maintained to the present day; and though a vast number of these strings are made both in England and various parts of the Continent, the "Roman strings," as they are called, are justly held in the highest estimation. It is a well-known fact that the membranes of lean animals are much tougher than those of animals in a higher condition, and it is to this fact that the superior quality of the strings made in Naples is due, since the sheep from which the raw material is obtained are exceedingly small and also lean. The strings made from the intestines of the fat sheep of the London market are well known to be greatly inferior in toughness and durability to those of Neapolitan make; and from the frequency with which the former break when being tuned up to concert pitch, they often cause much disappointment, irritation, and inconvenience to musicians.

Treatment of the Intestines.—The intestines being cleansed as before, are steeped in the potash leys (clarified with a little alum), progressively stronger each day, for four or five days, until they are sufficiently swollen and bleached. They are then passed through the thimble, and again cleansed in the ley, after which they are washed, twisted, and sulphured for two hours, which operation is sometimes repeated several times. They are next polished with horse-hair cords and dried. The strings are known to be sufficiently dried when one of the strands, upon being removed from its peg, shows no disposition to curl, but remains perfectly straight in the position in which it is held. When the strings have reached this point they are rubbed over with olive oil, cut at the ends, and coiled up.

The violin *fourth* strings, which are covered with plated copper wire, are neither sulphured nor oiled. The string to be wire-covered is cut off to the length of $1\frac{1}{4}$ yard; one

of its ends is attached to the hook of the wheel and the other to the ring of a whirl, which keeps the string stretched by means of a weight at the end of a cord fastened to it, and passing over a pulley. The wire is then fastened around the string close to the whirl, and as the wheel is made to revolve the string and the whirl turn with it. The workman supports the string with his left hand, and the wire passing through his right hand is made to revolve around it in close spiral turns until it is entirely and equally covered (*Dussauce*). The utmost skill and dexterity on the part of the workman are required for the manufacture of violin and harp strings, which he can only acquire by extensive experience and care.

CHAPTER XXXVI.

GLUE-BOILING.

Treatment of Glue-pieces, &c.—French Glue.—Parchment Glue.—Size.—Glue Waste.

Treatment of Glue-pieces, &c.—The glue-pieces and other animal matters used in the manufacture of glue are put into a large tank containing milk of lime, in which they remain for about two weeks, the lime being renewed several times. They are then taken out, with the lime which adheres to them, and spread out in a layer two or three inches thick upon a sloping pavement to drain and dry, being turned over by means of prongs several times a day. The action of the lime destroys all the tissues, blood, &c., rendering them soluble, by which they become separated from the glutinous matter, which is thereby put into a condition to dissolve more freely in hot water. By exposing the lime to the action of the air, it loses its causticity by attracting carbonic acid, and is thus prevented from acting injuriously upon the glue when the materials are boiled. The glutinous matters are next put into baskets and washed in a stream of water, after which they are placed, while still wet, in a flat-bottomed copper boiler, furnished with a perforated false bottom to protect the animal matter from being burnt by the heat of the fire.

First Boiling.—The copper is filled about two-thirds with soft water, when the washed material is introduced and piled up above the flange of the boiler; the fire is then kindled, and as the heat increases the material sinks into the liquid, and after a few hours becomes completely immersed in the liquid. During this time the contents

of the boiler are frequently stirred, and the whole boiled gently.

Drawing off the Liquor.—The liquid is drawn off by a tap connected to the bottom of the boiler, and beneath its false bottom, and the first, second, and third liquors, representing different qualities, are reserved for glues of proportionate value, the product gradually decreasing in value as the boiling progresses. It has been proved that gelatine undergoes various changes of condition after it is dissolved by continued boiling, and it should therefore be drawn off whenever it is sufficiently strong to form a clear gelatinous mass on cooling, and which will cut into tolerably firm slices with a thin wire. This is readily ascertained by putting a little of the liquor in a small vessel and exposing it in the air to cool, when in the course of a few minutes it should gelatinise; if such is not the case, the boiling must be continued for a longer period. As soon as the proper condition of the liquor is reached the fire is checked, and the contents of the boiler allowed to settle for about fifteen minutes. The tap or stopcock is then turned a little and all the liquor allowed to flow into the settling copper, situated below the first, and which is immersed in a hot-water bath to keep the fluid hot.

Gelatinising.—After three or four hours the clear liquor is run off into a series of square wooden boxes slightly narrower at the bottom than at the top. The bottoms of these boxes are cross-grooved to regulate the size of the squares of glue. These boxes are placed very level on the stone floor of the apartment, which must be rendered very clean, so that in the case of leakage the glue may be recovered. The liquid glue is poured into the boxes through a funnel, provided with a filter-cloth, until it reaches the upper rim of each box. The apartment requires to be very dry and cool to aid the solidification of the glue.

Cutting.—If the boxes have been filled overnight, the glue will generally be sufficiently firm to cut on the following morning. The boxes are then removed to a

well-ventilated upper loft, in which the air is admitted from all points; they are then carefully turned upside down upon a table, previously moistened to prevent the glue from sticking to it. The glue is then loosened from the sides of the boxes by passing a moist long-bladed knife round the inner sides. The block of glue is first cut into slices horizontally by means of a thin brass wire stretched in a frame like that of a frame-saw, and the cuts are guided by rulers placed at proper distances to suit the required thickness of the glue cakes. The square cakes are formed by cutting with a moist knife through the lines formed by the grooves in the bottom of the box.

Drying.—The gelatinous squares are next lifted very carefully and laid upon nets stretched upon wooden frames; as each frame is filled another is placed above it, to be filled in its turn, and so on. The frames are set over each other, with a space of about three inches between, and upon small wooden pegs fitting into holes in uprights fixed round the room, so that the air may have free access on every side. The frames, supported by the wooden pegs, slide to and fro like a drawer, which enables the workmen to shift them from time to time, to turn the cakes over, which is done two or three times each day.

There is no detail in the manufacture of glue which is so uncertain as that of drying the jellified material, especially in the earlier stages; if the temperature of the atmosphere should rise above a certain degree, the gelatine may *run*, and trickle through the netting upon the cakes beneath, or may become just sufficiently soft to firmly attach itself, when drying, to the netting, rendering it necessary to plunge the net into boiling water to disconnect the cakes; and even if these untoward difficulties do not arise, the augmented temperature will render the cakes so soft as to put them out of proper shape. Again, if the gelatine become frozen, the cakes are liable to crack, and thus necessitate remelting. In damp and foggy weather the glue is liable to become mouldy on the surface, while

if the air be too dry and hot, it is likely to dry too rapidly, causing it to crack in numerous places. The only remedy for the above evils is to keep the flaps of the drying-room windows closed as occasion may require, and if possible to conduct the operation in the spring or autumn. When the cakes have been dried upon the nets they may still retain a certain amount of elasticity, which would render them unsaleable; when such is the case they require to be dried in a stove by moderate heat.

Glossing.—In order to give the cakes the bright glossy surface which is characteristic of this article, the dried cakes are dipped one by one into hot water for an instant, and they are then brushed over with a brush, also dipped into hot water. The cakes are then spread upon a hurdle, and are afterwards placed in the stove-room if the weather be damp, until the surfaces are perfectly dry, when they are ready for packing into casks for sale.

Second Boiling.—After the first liquor has been removed as before described, fresh water is put into the copper, and the boiling continued until the mass has a gelatinous appearance, when the liquor is drawn off by the stopcock as before, and is then submitted to the same operations as the first liquor.

Third Boiling.—The remaining *grounds* are next treated with a fresh supply of water, or weak liquors containing some gelatine. The bottoms, or grounds, are afterwards taken out of the boiler and placed in bags, which are submitted to pressure to extract as much of the liquor as possible.

The above three boilings yield three different qualities of glue. The first is pale coloured, and is the most suitable for uniting all kinds of woodwork. The second and third qualities are often preferred, however, by workmen who innocently believe that a dark-coloured glue has the strongest adhesive power.

French Glue.—This is made from the gelatine of bones. The bones are first treated with hydrochloric acid, which dissolves the phosphate of lime, leaving the gelatinous substance of the bones in a soft and soluble condition,

which is afterwards dissolved and converted into glue. The product is, however, of very poor quality, and is soluble in cold water—a proof of its inferiority. Good glue does not dissolve in cold water, but is merely softened by it.

Parchment Glue is prepared from the *shreds* or *shavings* of parchment, vellum, white leather, &c., by boiling in water; it is nearly colourless, and without odour.

Glue of inferior quality may also be prepared from the tendons and other offals of the slaughter-house, but the refuse of the tanneries, such as the ears of oxen, calves, sheep, &c., form a better glue stock, while the parings of ox and cow hides are the best of all materials for glue-making.

Size.—Ordinary size, such as is used in plastering and other coarse work, is prepared from the same materials as common glue, but the liquid is not evaporated to so great an extent as is requisite for the latter substance; being always kept in a soft condition so as to be readily soluble in water, the gelatine solution is made of such a strength that, when cold, it will set into a firm jelly, or, as it is called, *size*. Other varieties, of a superior quality, are, however, prepared for manufacturing *gelatine*, for thickening soups, and other domestic purposes, from selected materials, such as calves' pates, &c. In preparing this quality of size greater care is taken to remove the lime than is necessary in ordinary glue-making, and to accomplish this the pieces, after liming, are treated in a very dilute solution of hydrochloric acid. The boiling is usually effected by means of steam-heat, and the liquid, when in the proper condition, is either run out into small casks for sale, or into large vats, and when cold is broken up and packed in casks. For making the finest qualities of size, for use as an article of diet, steam jacket-pans are employed in boiling the materials. The size used by paper-makers is of the best quality manufactured by ordinary glue makers.

Glue Waste.—The refuse left after the final boiling is thrown aside for manure. Since it rapidly decomposes,

however, it soon becomes offensive, rendering its removal exceedingly unpleasant after about twenty-four hours. MM. Leblanc, of Lyons, have discovered in this refuse matter a considerable quantity of a fatty substance, which can be used in the manufacture of soap as well as for lubricating purposes. It can be extracted by means of bisulphide of carbon, petroleum, benzol, &c., but sulphuric acid is recommended as being cheaper and safer in use. A vessel capable of holding from 50 to 100 gallons, heated by steam or otherwise, may be used for the purpose.

For 220 lbs. of refuse, 11 gallons of water are taken and acidified with sulphuric acid, till it stands at about 6° to 8° Baumé. The whole is then boiled, and after a suitable mixing has been effected, sulphuric acid of 48° Baumé is poured in by degrees, until a complete saturation has taken place, or until the fatty substance has been separated. The quantity of the 48° acid varies according to the greater or lesser proportion of gelatine in the waste. It averages about 10 per cent. This operation lasts about two or three hours.

The mass is then placed in cloths, each holding about 35 to 45 lbs., and these are placed under a hydraulic press with a division between each cloth. The fluid obtained is directed into receptacles, and the fatty substance on the top is removed. The pressed cakes remaining are very rich in nitrogenous substances, which are as effective for manuring purposes as the refuse in its original form. The cakes are dried, and can then be stored until required for use.

CHAPTER XXXVII.

UTILISATION OF TANNERS' WASTE.

Spent Tan.—Guest and Court's Process.—Hide and Skin Cuttings.—Hair Waste.—Lime Waste.—Glucose in Leather.

Spent Tan.—When we reflect upon the vast quantity of tan refuse that is annually produced in the United Kingdom we cannot be surprised that many efforts should be made—even by persons outside the trade—to turn this waste material to practical account. It had long been the practice at some tanneries to employ it when dried, or partially dried in the air, as fuel; again, a considerable quantity has been, and is now, used as manure. In 1852 Mr. J. B. Hoyt, of New Jersey, conceived the idea of burning wet spent tan in a detached brick furnace, and succeeded in obtaining sufficient heating power to drive his machinery by its agency, and practically adopted this method of utilising the waste tan from that time. The great success of his system created quite a revolution in the American tanneries, and its adoption became general. In this country Messrs. Huxham and Browns have constructed a tan-burning boiler, which, we believe, has proved very efficient.

Another and still more important use for spent tan—should any of the patented processes prove successful—is in the conversion of the fibrous waste into pulp for paper-making. This would doubtless be the most profitable purpose to which the material could be applied if an effectual and economical method of pulping and bleaching could be introduced. In 1881 Messrs. Guest and Court obtained a patent for converting waste tan into pulp for

paper-making, the abridged process of which is given below.

Guest and Court's Process.—The spent tan is put into a hopper, from which it gradually passes between, and is crushed by, two or more revolving rollers, the object of which is to open the fibres and break up the knots of the waste material. The inventors prefer to feed the rollers with the spent tan in a semi-dry state. The fibres being thus separated to some extent, the mass is introduced in convenient quantities into a rotary boiler or agitator containing a solution of caustic soda in the proportion of one-twentieth part to the water used. The boiler is then closed, steam admitted, and the whole agitated by means of arms or cutters in the interior, and the separating or opening (disintegrating) process maintained. The mass may be washed in the boiler or in a separate vessel. When it is desired to bleach the mass, it is subjected to the action of bleaching materials. In the event of any such process becoming really practicable, it would then be worth while to keep spent bark separate from valonia, &c.

Hide and Skin Cuttings.—These are commonly called "glue pieces," and are disposed of to the glue manufacturers, but their value depends greatly upon the care taken to preserve them from decomposition. This is more especially important when they are to be used for making size for paper-making, since the least smell or "taint" would be noticeable in the paper, and greatly reduce its value. It is also very important that the fine glues used in bookbinding should be free from objectionable smell; therefore it will be well understood that the value of the glue pieces will depend upon their not having undergone decomposition while in the possession of the tanner. When it is borne in mind that glue pieces which have become tainted can only be employed for making what is known as carpenters' glue, their preservation from decomposition should be a matter of great consideration in order to maintain their proper value.

Respecting the preservation of glue pieces, Jackson Schultz makes the following observations: "Whether

from green or dry stock, the trimmings should be thrown into weak lime as soon as they leave the beam, and should be retained in this lime until the hair will almost drop off; when in this condition they should be thrown into a revolving wheel (tumbler), or may be put into the hide mill, and worked until all the hair has been separated from the pieces. If a bountiful supply of water has been allowed to run on while the wheel or mill was in operation all the hair will have worked off and separated from the pieces, which will then have parted with so much of their lime as to make them, when dry, flinty and hard; to avoid this they should be thrown back into the lime for a few days, and again 'raised.' Before they are taken out to dry they should be thoroughly washed. The drying should be in the open air, and if on a flat board surface the pieces should be frequently turned. Care should be taken to wash off all the loose lime, so that the pieces may present an attractive uniform white and clean surface. When they are fully dried, they should be pressed into uniform bales [cakes]. Under no circumstances should any tainted or damaged piece be allowed to go into the bale. Paper-makers will use such hide offal for sizing, and pay three or four cents per pound more for it than glue-makers can afford to pay. Calf skin shanks and pates are worth more for this purpose than hide cuttings, and should always be kept separate."

The above observations of a thoroughly practical and successful tanner should command attention, and which they will doubtless receive, from those who are desirous of deriving the full advantage from such valuable offal as the trimmings of hides and skins. The cuttings from neat cattle are more valuable than those of the sheep, while those from goats are of less value than the latter.

Hair Waste.—Formerly cattle hair was only used by plasterers to promote the binding properties of mortar, but of late years this material—especially calves' hair—has been employed in the manufacture of cloth, carpets, and felting. It is of importance, therefore, that this waste product should be preserved and rendered saleable by

being well cleaned and washed. For this purpose hair washing machines have been introduced.

Lime Waste.—If we bear in mind the very small amount of lime which water is capable of dissolving, namely, only 88·48 *grains* per gallon at the temperature of 60° Fahr., the common practice of putting the cleansed skins or hides into what is termed "weak lime," or "old lime"—that is to say, lime that has been used over and over again—would appear to be open to objection. When these old liquors contain little or no caustic lime *in solution*, and chiefly carbonate of lime as the residuum, it is questionable whether the cost of labour in handling and loss of time involved in what may be *an inert process*, would not be better applied to treating the skins in really active (that is, fresh) liquors. The cost of lime is but small, and the amount actually exhausted in the process of depilation cannot be much. We venture to suggest, therefore, that economy would be found, not in trying to get a little more out of weak liquors, but in discarding them altogether so soon as they give evidence of inaction. Again, the practice of using large proportions of lime in charging a pit would seem to be objectionable, and for this reason: when the lime has freely acted upon the fatty matters of, say, 100 hides, the liquor becomes a solution of lime-soap, and it is doubtful whether in this condition it is capable of holding much, if any, free lime in solution. If this be so, the liquor would become inoperative as a depilatory, no matter how much lime might remain at the bottom of the pit. Schultz urges that no undissolved lime should enter the pit; and although we cannot go quite so far as that gentleman, we do think that a much smaller proportion of lime than is usually adopted would answer every purpose, and would be far less wasteful. Our reason for differing from the great American authority is, that we believe the undissolved lime—which becomes diffused through the liquor by the operation of *plunging* each time the skins are returned to the pits—has a direct and powerful action upon the animal tissues, the epidermis and subcutaneous areolar tissue, independent of the dissolved lime, which, as

we have shown (p. 117), only amounts to 11·6 grains in each pint of the liquor at ordinary temperatures. When the liquors are highly "soapy," if we may use the term, the action of the lime would be retarded.

The lime waste of the tanneries is disposed of as manure, but the waste liquors are not so easily got rid of, since if they are suffered to run into rivers these streams would soon become uninhabitable to the finny tribe. A small quantity of sulphuric acid, added to the exhausted lime liquors, would liberate the fatty acids of the lime-soap, and these could be collected as a scum from the surface. If this were done exactly to the point of saturation (that is to say, without excess of acid), the waste liquor would be rendered innocuous, and its entrance into rivers would be at all events comparatively harmless. If a small portion of lime happened to be present in the waste liquor, this would be thrown down as an insoluble sulphate of lime.

Glucose in Leather.—It has been stated that the falsification of the weight of leather, by adding glucose, or grape sugar, is carried on somewhat extensively, and the shoe trades are seeking protection from this system of fraud. The presence of glucose in leather may be ascertained in the following way: Steep a piece of the suspected leather in a little water for twenty-four hours, when the glucose will become dissolved, forming a thickish syrupy liquid. Or, if two pieces of the leather be moistened and then placed together and left for a time, they will be found to adhere firmly, which in the case of pure leather would not occur. It is stated that samples of sole leather have been found to contain from 30 to 40 per cent. of glucose, but this seems incredible. It is a peculiarity of leather treated with grape sugar that after being wetted it is difficult to dry.

FRENCH METRICAL OR DECIMAL MEASURES OF LENGTH.

Names.	Eq. in Mètres.	Equivalents in English Inches at 32° Fahr.	English Long Measure at 62° Fahr.				
			Miles.	Fur.	Yds.	Feet.	Inch.
Millimètre ..	·001	·03937					
Centimètre ..	·01	·39371					
Décimètre....	·1	3·93708					
Mètre	1·	39·37079			1	0	3·37
Décamètre ..	10·	393·70790			10	2	9·7
Hectomètre ..	100·	3937·07900			109	1	1·078
Kilomètre....	1000·	39370·79000		4	213	1	10·3
Myriamètre ..	10000·	393707·90000	6	1	156	0	9·17

*** The *standard unit* of the above table is the *mètre*, which has been determined to be 39·37079 inches at 32° Fahr. (Capt. Kater); the English foot is taken at 62° Fahr. The *true* length of the mètre, reduced to the latter temperature, is 39·370091 English inches, a number which varies from that in the table only at the fourth decimal figure. It will be perceived that the principle of nomenclature adopted in applying the names, was to prefix the *Greek* numerals to the *decimal multiples*, and the *Latin numerals* to the decimal subdivisions.

FRENCH METRICAL OR DECIMAL MEASURES OF VOLUME.

Names.	Eq. in Litres.	Eq. in English Cubic Inches.	Equivalents in English Measures.				
			Gall.	Pints.	Oz.	Drms.	Minims.
Millilitre	·001	·0610					16·9
Centilitre	·01	·6103				2	49·
Décilitre	·1	6·1028			3	4	10·36
Litre	1·	61·028		1	15	1	43·69
Decalitre	10·	610·28	2	1	12	1	16·9
Hectolitre....	100·	6102·8	22	0	1	4	49·
Kilolitre	1000·	61028·	220	0	16	6	40·
Myrialitre ..	10000·	610280·	2201 (=275⅛ bushels).				

*** The *standard unit* in the above table is the *litre*, or the cube of the one-tenth of a mètre. The French *centiare* contains 1 square mètre; the *are*, 100 ditto; the *hectare*, 10,000 ditto. The *old Paris pint* is equal to 1·678 English imperial pint.

††† The capacity of solids and aëriform fluids is taken in cubic inches or feet, in England. In France, the *stère*, or *mètre cube*, equal to 35·31658 English cubic feet, is the standard unit.

Weights and Measures of the Metrical System.

From the British Pharmacopœia.

Weights.

1 Milligramme = the thousandth part of one gramme, or 0·001 gramme
1 Centigramme = the hundredth „ „ „ 0·01 „
1 Décigramme = the tenth „ „ „ 0·1 „
1 Gramme = weight of a cubic centimètre of water at 4° C. 1·0 „
1 Décagramme = ten grammes . . . . . 10·0 „
1 Hectogramme = one hundred grammes . . . 100·0 „
1 Kilogramme = one thousand grammes . . . 1000·0 (1 kilo.)

Measures of Capacity.

1 Millilitre = 1 cubic centimètre, or the measure of 1 gramme of water.
1 Centilitre = 10 „ „ „ 10 „ „
1 Décilitre = 100 „ „ „ 100 „ „
1 Litre = 1000 „ „ „ 1000 (1 kilo.)

Measures of Length.

1 Millimètre = the thousandth part of one mètre, or 0·001 mètre.
1 Centimètre = the hundredth „ „ 0·01 „
1 Décimètre = the tenth „ „ 0 1 „
1 Mètre = the ten-millionth part of a quarter of the meridian of the earth.

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